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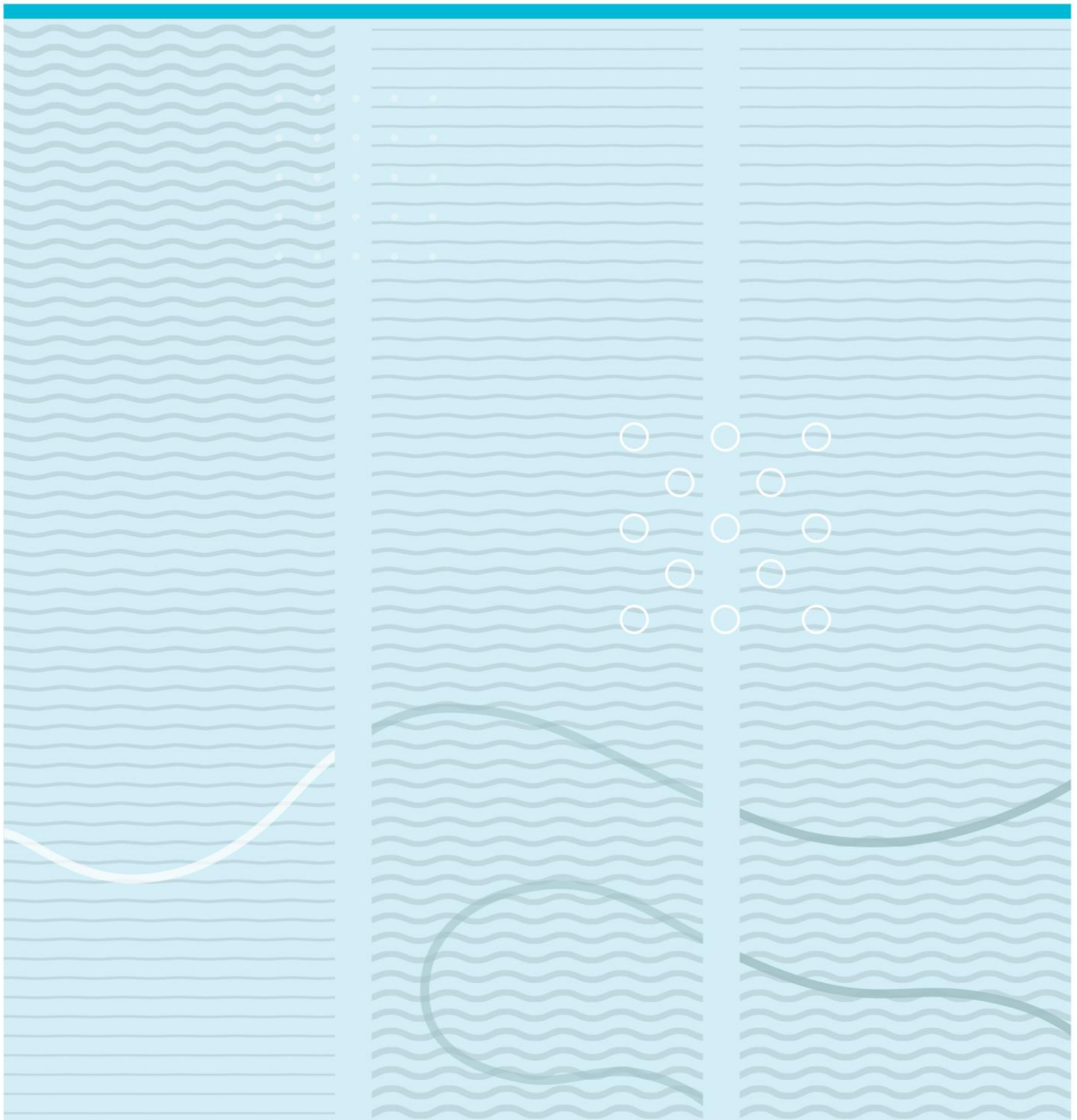
Tobias Møretrø

Product Innovation in Large Firms

How do large firms that produce high technological products organize for product innovation, and what methods do they use to promote innovative behaviour?

Executive Summary

Companies today are faced with global competition, resource scarcities, rapid technological advances and companies have to be able to innovative in order to grow, be efficient, or even just survive in the marketplace. The concept of innovation is central to economic growth, and it can lead to sustained competitive advantage, which is something that firms should strive to achieve. Innovation is intentional and it requires that individuals are motivated. Therefore, it is very important for managers to know how to motivate their employees.

How firms should organize and what methods they should use for different types of product innovations seem to be inconsistent and lacking in the literature. To generate more knowledge and a better understanding in this field, the research question for this study is formulated as:

> *"How do large firms that produce high technological products organize for product innovation, and what methods do they use to promote innovative behavior?"*

This thesis investigates several aspects that are important in terms of how large firms that produce high technological products organize and what methods they use for product innovation. Some of the aspects surrounding the research question are the firm size, firms' willingness to cannibalize own investments, R&D departments, and what types of innovation they produce.

Five large firms that produce high technological products operating in different industries were investigated using in-depth interviews for data collection for this study. A holistic multiple case study design with an inductive approach was used in this study. Existing literature were first reviewed before data was gathered.

From the analysis of the collected data, it was evident that many of the findings supported the theories reviewed from existing literature, but some were also contradictory. All of the companies in this study except from one had R&D department, which the literature also suggested that they should have. Four of the studied companies primarily focused on producing incremental innovations, while the last one focused more on radical innovations. Three of the investigated companies were using a matrix organizational structure, and it was seemingly an issue that some people worked on too many projects. All of the companies studied were following some sort of method or process for product innovation. One company had a self-made model they were following, while three of the others were using the Systems Engineering Vee-model. It was also evident from this study, both from the literature review and from the interviews, that the culture in the organizations is a key determent of their ability to do product innovations.

Sammendrag

Selskaper blir i dag møtt av global konkurranse, knapphet av ressurser, hurtige teknologiske fremskritt og bedrifter er nødt til å være I stand til å være innovative for at de skal vokse, være effektive, eller til og med bare for å overleve i markedet. Konseptet innovasjon er sentralt for økonomisk vekst, og det kan føre til bærekraftig konkurransefortrinn, som er noe bedrifter burde strebe etter å oppnå. Innovasjon er bevisst, og det krever individer som er motiverte. Derfor er det viktig at ledere vet hvordan de kan motivere sine ansatte.

Hvordan bedrifter bør organiseres, og hva slags metoder de burde bruke for ulike typer produktinnovasjoner virker å være inkonsekvent og manglende i litteraturen. For å generere mer kunnskap og få en bedre forståelse av dette feltet, er forskningsspørsmålet for denne studien formulert som:

"Hvordan organiserer høyteknologiske selskaper seg for produktinnovasjon, og hva slags metoder bruker de for å fremme innovativ atferd?"

Denne avhandlingen undersøker flere aspekter som er viktig i forhold til hvordan store høyteknologiske selskaper organiserer og hvilke metoder de bruker for produktinnovasjon. Noen av de aspektene relatert til forskningsspørsmålet er bedriftens størrelse, bedriftens villighet til å kannibalisere egne investeringer, R&D avdelinger, og hvilke typer innovasjoner de produserer.

Fem store høyteknologiske bedrifter som opererer i ulike industrier ble undersøkt ved hjelp av dybdeintervjuer for å samle data til denne studien. Holistisk 'multiple' case design med en induktiv fremgangsmåte er blitt brukt i denne studien. Eksisterende kunnskap ble først gjennomgått før datainnsamlingen startet.

Fra analysen av innsamlede data var det tydelig at mange av funnene støttet teorier som var blitt gjennomgått fra eksisterende litteratur, men noen funn var også motsettende. Alle selskapene i denne studien, bortsett fra en, hadde R&D avdeling, som også litteraturen foreslo at de burde ha. Fire av de selskapene som ble studert fokuserte primært på å produsere inkrementelle innovasjoner, mens den siste bedriften fokuserte mer på radikale innovasjoner. Tre av de undersøkte selskapene brukte matrise organisasjonsstruktur, og det var tilsynelatende et problem at noen personer endte opp med å jobbe i for mange prosjekter. Alle selskapene i studien fulgte en type metode eller prosess for produkt innovasjon. En av selskapene hadde en selvlaget modell som de fulgte, mens tre av de andre selskapene brukte Systems Engineering Vee-modellen. Det var også tydelig fra studien, både fra litteratur gjennomgangen og fra intervjuene, at kulturen i organisasjonene var en nøkkel som spilte en stor rolle i deres evne til å skape produkt innovasjoner.

Table of contents

Preface

The presented study marks the termination of the master's program in Business Administration and Management, with specialization in Industrial Business Management at the University College of Southeast Norway.

One of the motivational factors for undertaking this particular study was that I was part of a yearlong project, for a large-scale global company producing high technology products, in a multidisciplinary and international group of students. From this project, a lot of interest, but also impressions were made of how large firms that produce high technological products organize for-, and what methods they use for product innovation.

Based off the interest gained from the project, I conducted a literature review on the Design Thinking Methodology during the spring of 2016. From this, I shifted the focus more in general bout how to organize and what methods that can be used for product innovations, which lead towards the research question of this study.

I would like to thank all the informants that let me interview them and make this study possible. I would also like to thank my supervisor, Roland Hellberg, who always was fast to answer if any guidance or help was needed. Finally, I would like to thank Kristin Falk for helping me to get in touch with case study organizations through her contact network.

1. Introduction

This chapter begins with a background about the theme and motivation for undertaking this study. After he background and motivation, some clarifications about the scope of the study are presented followed by a presentation of the companies under investigation in this thesis. Finally, the structure of the study is presented through the thesis disposition.

1.1. Background and motivation

Companies today are faced with global competition, resource scarcities, rapid technological advances and companies have to be able to innovative in order to grow, be efficient, or even just survive in the marketplace (Damanpour and Wischnevsky, 2006). The concept of innovation is central to economic growth, and it can lead to sustained competitive advantage, which is something that firms should strive to achieve. Innovation is intentional and it requires that individuals are motivated (Monge, Cozzens, and Contractor, 1992). Therefore, it is very important for managers to know how to motivate their employees.

In innovation studies, the size of the organization is an important contextual variable, and the size of the organization have typically been associated as a predictor of how good or bad the company is in regards to producing different types of innovations. However, the literature results in regards to the relation of firm size and innovativeness are inconsistent (Camisón-Zornoza et al, 2004).

Product innovations can also be distinguished to different types of innovations dependent on the technological newness and the perceived need fulfillment by the users (Chandy and Tellis, 1998). How firms are organized have an important effect on their ability to pursue these different types of innovations, as some structures are seen as more effective for either very new products, or incremental changes on others. There are also many different product innovation processes that firms can follow for guidance in how to do product innovations.

Knowing how to organize for product innovation, and what methods and tools to use to promote innovative thinking in large firms that produce high technological products are confusing and inconsistent presented in the literature. There is a lack of research regarding how firms organize and what methods they use dependent on the types of product innovations they produce.

1.2. Research question

Based on the preceding discussion, how firms organize, and what methods they use to promote innovative behavior are very important in regards to their ability to be competitive in the global marketplace. How firms should organize and what methods they should use for different types of product innovations seem to be inconsistent and lacking in the literature. To generate more knowledge and a better understanding in this field, I have chosen to investigate how large firms that produce high technological products in different industries organize, and what methods they use for product innovations. Large firms was defined as a company with 2500 or more employers by Chandy and Tellis (1998), and the reason this was a variable chosen for this study was to have some sort of homogeneity, so a replication would be easier and possible generalization of findings could be stronger. The research question for this study is formulated as:

"How do large firms that produce high technological products organize for product innovation, and what methods do they use to promote innovative behavior?"

This is a very broad and general research question. How companies organize and what methods they consist of many different variables, and the terms can be interpreted differently. Because there is a lack of research on this field, I believe that a broad research question will provide comprehensive insights. By having a broad research approach in this study, other studies can build on the findings in this thesis in a more narrow scope.

The focus of this study is not generally to compare how the different companies organize and what methods they use for product innovation, but rather to learn from them about how it is possible to organize and what methods are being used for product innovations.

Because the research question is so broad, I also created some operationalized questions that should help me answer the research question. Following are the operationalized questions::

1. *How do large firms that produce high technological products organize for product innovation?*
   a. Why do they do it that way?
   b. Do they have independent departments for innovation? One for incremental innovation and one for radical innovation?
   c. Does this differ dependent on the size of the business?
2. *What kind of product innovation methods, tools or frameworks etc. does firms that produce high technological products use to come up with new ideas/ products?*
   a. Do they have planned workshops, do they appear randomly or do they have special departments for incremental and radical product innovation?
   b. What competence is included in the product development phase?

These sub-questions, or operationalized questions also have some assumptions related to them, however, this was not reflected to the informants when conducting the study, this is rather to make the operationalized questions easier to understand.

1.3. Clarifications

This study focus on some very broad topics such as innovation, organizing, and methods, and hence I find it necessary to declare what parts that are under focus for this study. Innovation comprises of many elements, and can be process innovation, product innovation, marketing innovation and organizational innovation. In this study, the primary type under investigation is product innovation. How companies organize for innovation can also be a very broad term, but the focus is mainly the parts of the organization that are specifically organized in a way to promote innovative behavior. In terms of methods and processes, the primary focus is on the early phase of product innovation and how companies come up with the ideas.

1.4. Presentation of organizations

It was important for this study to preserve the anonymity of the individuals and their firms under study and the confidentiality of certain elements of their business. Because of this, a very general presentation of the companies are provided in the table below with the informants' position in the company, their experience they have, the approximate revenue the company had in 2016, the industry they operate in, and approximately how many employees they have.

	Position	Years in this company	Years working with innovation	Industry	Reveue 2016 (Aprox.)	Employees (Aprox.)
Company 1	R&D Engineer	2	15	Vehicle	1B €	12 000
Company 2	Manager Technology Group	15	25+	ENERGY	$ 19.5B	40 000
Company 3	Leader Continuous Improvements	10	25+	Aerospace	$ 3.5B	18 000
Company 4	Senior System Developer	7	22	Defence and Aerospace	4B NOK	2 000
Company 5	Program Manager and Sales Manager	5	28	Maritime, Energy, Defence, Vehicle etc.	2B SEK	2 000

Figure 1: Presentation of the companies and informants

1.5. Disposition

In this section, I will provide the disposition of this thesis. In the next chapter, a theoretical review of existing theory that are relevant to the research question are presented and discussed. In the third chapter of this thesis the methodological choices taken in regards to the research approach, the design of the study, selection of case and informants, how the data was collected and analyzed, and the quality criteria for this study are carefully explained and reasoned for. In chapter four, the data collected for this study are analyzed and compared to the literature, and in chapter five, the results are discussed in relation to research question. In chapter five the conclusion, implications, reflections and finally my suggestion for further research are discussed.

2. Literature review

In this thesis, I study how large firms that produce high technological products organize for-, and what innovation methods or tools they use for product innovation. The purpose of this chapter is to provide theoretical foundation, insights into existing literature surrounding the field of study, and underpin the need for this study. The theoretical insights are very important as they serve as the foundation for the rest of the study. First, how literature have been searched to find relevant literature is described. Secondly, the conceptual approach for this study is described by reviewing innovation literature. After briefly reviewing innovation literature, additional underlying related topics are discussed, such as product innovation, types of product innovations, firm size in relation to innovativeness, organizing for innovation, and methods and tools for product innovation. For some of the topics, such as innovation and product innovation, there exist lots of literature, whereas for some of the other, the literature is more limited. Innovation is also a term that have been interpreted differently by individuals, and therefore, seeking through literature in this field can be somewhat hard if you do not know what key terminologies to search for.

For this study, the primary sources to seek for relevant literature have been the general databases Google Scholar and Oria, however, other databases have been used such as Web of Science. When searching for literature, I started wide, and then converged towards more specific search words or sentences as the study proceeded, as I knew more what I was looking for. Selecting literature with high citation numbers was of focus as the literature was broad, but as it narrowed down to more specific topics, there was less citation of the articles available. Articles and books used for this study have been carefully selected based on relevance and quality. In order to reduce the risk of overlooking other relevant literature with good quality, I screened out articles based on search words, and out of the articles and books chosen for the topic based off the title, the abstract of the articles was read to see if they were of relevance for this study.

By searching in this manner, many articles can be looked through in a fast way, while still finding out what the essence of the articles were, before eventually reading them in depth. I searched through the reference lists provided in the literature used, and I also searcher to see what articles or books that had referenced the chosen literatures. This was done both in order to expand the theoretical research, and to confirm the quality of the literature.

This chapter present general existing literature about product innovation, how companies organize for innovation, what effect size can have on innovation, and some literature on tools and methods that can be used for product innovation.

2.1. Innovation

Schumpeter is a heavily cited innovation research author, and in 1934, he stated that the concept of innovation is central to economic growth and can lead firms to sustained competitive advantage. Schumpeter is according to Śledzik (2013) regarded as one of the greatest economists of the 18th century, and was considered one of the first to lay out a clear concept of innovation. Looking at more recent contributions to innovation research, Rogers (2010) defined innovation as an idea, practice or object perceived as new by an individual or other adoption units. Classifying an idea as new or not (newness) have been vastly discussed (Damanpour and Wischnevsky, 2006), but newness is a relative term. Rogers (2010) argued that if an individual sees an idea as new for them, it is an innovation. Generating innovation will give outcome of either a product, service, or technology that is regarded as new at least for the company (Damanpour and Wischnevsky, 2006). By generating innovation, the firm's effectiveness and competitiveness should be improved by either making use of existing opportunities or creating new opportunities (Drucker, 1985). Dougherty and Hardy (1996) argued that firms that introduce products, services or technologies that are new to the market, are innovation-generating companies. Companies that generate innovation covers all activities and efforts from opportunity recognition and idea creation to getting them to work (Roberts, 1988; Decelle, 2004). From this statement, innovation is not just an idea, but is actually something feasible (product, service, or technology). Brown stated in 2008 that leaders look at innovation as a primary source for differentiation and competitive advantage. In order to grow,

be efficient, and even just survive, companies must innovate, because of the resource scarcity, global competition, and rapid technological advances they face (Damanpour, Wischnevsky, 2006).

Amar and Juneja (2008, p. 299) argue that you can separate between innovation and invention, whereas "invention provides the base for new technological paradigms and trajectories that become responsible for the destruction of extant technologies, products, and techniques", and that invention can be a form of innovation, but that innovation is possible without invention. Innovation can be marketing strategies, organizational design, products, services, processes and techniques, and it can include reinvention, where an invention is modified or changed to make it adoptable (Rogers, 2003). In this way, innovation is a very broad term.

A short introduction to what innovation is, and some opinions on what it encompasses have been presented. Gunday, Ulusoy, Kilic, and Alpkan (2011) distinguished four different types of innovations, namely process innovation, product innovation, marketing innovation, and organizational innovation. To limit the scope of the study, the focus will be on product innovation and mainly how to organize for innovation and what tools and methods that can be used to promote innovation. Product innovation will be discussed in the next section.

2.1.1. Product Innovation

The general focus of this study is on product innovation, and the focus is on how companies organize for-, and what methods or tools they use for product innovation. Product innovation is "the introduction of a good or service that is new or significantly improved regarding its characteristics or intended uses; including significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics" (OECD, 2005). It is critical for many organizations to create successful new products (Dougherty & Hardy, 1996), because of the resource scarcity, global competition, and rapid technological advances (Damanpour and Wischnevsky, 2006). Product innovation is one of the outputs that a company can get from an innovation as stated in the previous section.

Monge, Cozzens, and Contractor (1992) argued that innovation is intentional, and that that it required motivated individuals. If this is true, it is very important that the manager keep the employees motivated to be innovative. Empirical evidence shows that there are support among applications studies "encouraging knowledge-supporting culture in organizations, a culture where there is trust and comfort, lack of bureaucracy, ethical teams, symbiosis, and sharing in the success and failure of the organization" (Amar and Juneja, 2008, p. 306). This evidence suggest that these factors can contribute to more creative and innovative behaviors within the organization and hence lead to more product innovations. Innovation differ from creativity as creative acts can be done without a particular goal in mind, but innovation generally begins with a problem statement (Markman and Wood, 2009).

In the following sections, the effect of size on innovation, different types of innovation, how companies are organized for innovation, and what methods are used for product innovation will be discussed.

2.1.1.1. Firm size

In studies of innovation, organizational size is an important contextual variable (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés and Boronat-Navarro, 2004). Chandy and Tellis (2000) used a scaling to distinguish how many workers should be in an organization to call it large, and they stated that a company with more than 2500 workers is considered large. Damanpour and Wischnevsky (2006) argue that there are two sides regarding the relationship between size and innovation in organization management. On one side, small firms are considered more innovative because they are more flexible, better at adapting and improving, and can accept change better. On the other side, large firms are considered more innovative because they have more financial resources, facilities that are more complex, workers that are more skilled, and a higher technical knowledge and potential (Damanpour and Wischnevsky, 2006). The literature gives contradictory findings about the relationship between size and innovation (Camisón-Zornoza et al, 2004; Damanpour and Wischnevsky, 2006). Some argue that firm size and innovation have a positive relation and is the best predictor of innovation, (Damanpour, 1992; Dewar and Dutton, 1986; Ettlie, Bridges, and O'Keefe, 1984), while others believe firm size have a negative relation to innovation (Wade, 1996; Aldrich and Auster, 1986). Camisón-Zornoza et

al (2004) states that the literature have given the rise to one single conclusion, and that is that it is inconsistent.

Because of the inconsistency in the literature, the relationship between size and innovation is definitely an interesting topic, and something that needs further study. For my study, I wanted to mainly focus on large firms, and then possibly see if there is consistency in regards to innovation between these large firms, that could strengthen either of the sides in the literature. Another factor to take into account because this study will focus on large firms and product innovation, is what types of products is being produced. Kim and Huarng (2011), argue that innovation is more critical in the high technology industries. High technology industries is defined by Hathaway (2013, p. 2) as "industries with very high shares of employees in the STEM fields of science, technology, engineering, and math". In order to create consistency in my study, I wanted to focus on large firms that produce high technological products. In the next section, different types of product innovation are described.

2.1.1.2. Types of product innovation

In order to separate different kinds of innovation, I decided to use Chandy and Tellis' model on product innovation (see figure 2: modified model). Chandy and Tellis (1998) argued that there are four types of product innovations: 1. Incremental innovations, 2. market breakthroughs, 3. technological breakthroughs, and 4. radical innovations. These are dependent on the degree the technology differs from prior technologies and to what extend new products fulfills the needs of key customers better than existing products (see table below).

TYPES OF PRODUCT INNOVATIONS

		CUSTOMER NEED FULLFILLMENT PER DOLLAR	
		Low	High
Newness of Technology	Low	Incremental innovation	Market breakthrough
	High	Technological breakthrough	Radical innovation

Figure 2: Modified model based on Chandy and Tellis (1998, p. 476)

Radical innovation is defined by Troilo, De Luca and Atuahene-Gima (2014, p. 259) as offering of "new-to-the-world performance features, or significant improvements in known ones". Chandy and Tellis (2000) adds that radical innovation provides substantially higher customer benefits

compared to previous products in the industry. Based off the model, radical innovation provides the highest degree of newness of technology and the highest degree of customer fulfillment.

On the other side of the model is incremental innovation which provide the least newness of technology and the least customer need fulfillment. Incremental innovation is typically minor technological changes, and Chandy and Tellis (1998) gives an example of an incremental innovation which is that Fuji provided paper canisters instead of traditional plastic canisters.

Market breakthrough product innovations are based on the same core technology as existing products, however they provide substantially higher customer's need fulfillment (Chandy and Tellis, 1998). An example of this is a cable television that allow a higher number of channels through the existing cable.

Technological break through product innovation provide substantially higher degree of technological newness compared to existing solutions, however, it does not provide a higher degree of customer's need fulfillment (Chandy and Tellis, 1998).

This model give an illustration of types of innovation that differentiate innovation in a way that is easy to understand, and could therefore be a good tool to use when studying companies, in regards to what types of product innovation they produce. Christensen (2013) used different terms to differentiate between types of innovation than Chandy and Tellis, he distinguished between sustaining and disruptive innovation. Sustaining innovation were all products that improved the performance of established products, while disruptive innovations resulted in worse product performance, at least for short term (Christensen, 2013). Disruptive innovations typically underperform established products that are in the market, but they commonly provide other features that gives new customer value (Christensen, 2013).

Contrary to prior research suggesting that the main organizational predictor of radical product innovation is the firm size, Chandy and Tellis (1998) argue that firm's willingness to cannibalize own investments was one of the key variables to distinguish why some firms have records of strong radical product innovation compared to others. Willingness to cannibalize own investment is in my interpretation the degree a company are able to move away from an idea,

concept, or product if they learn that it does not fulfill the wanted outcomes, even though they have invested money into it. Chandy and Tellis (2000) stated that existing literature typically argue that large firms could not be radical innovators because of the theory of inertia. Theory of inertia suggest that as firms grow larger, they become more bureaucratic and slower to react, and hence less willing to take risk (Chandy and Tellis, 2000). This is, as stated in the previous section, a topic with inconsistent literature results.

2.2. Organizing for innovation:

In this subchapter, I will review some literature on organizing in regards to innovation. Most firms are able to occasionally create successful new products; however, many firms fail to repeat what they did because they were not organized to facilitate innovation (Dougherty and Hardy, 1996). How a firm is organized have an important effect on its radical innovation performance (Damanpour, 1991). In an innovation-generating firm one of the most critical issues are to manage the innovation project in an efficient and timely way in order to create a new technology, service, or product (Damanpour and Wischnevsky, 2006). Firms that generate radical innovations are typically associated with experimental structures, loose and decentralized structure, heterogeneous human resource profiles and strong technical competence (Tushman and Smtih, 2002). An efficiency culture, centralized structure, engineering work processes, formalized roles and coordinating mechanisms are typical traits of an organization producing incremental innovations (Tushman and Smith, 2002). Tushman and Smith (2002) also suggested a model where one unit in the organization focus on incremental innovation for short-term efficiency, while another unit focus on discontinuous innovations for long-term innovations. By organizing that way, the company could possibly produce both incremental and radical innovations. The unit that produce radical innovations should implement an organic structure (Tushman and Smith, 2002; Daft, 1978) and the unit producing incremental innovations should have a mechanical structure (Tushman and Smith, 2002). Damanpour and Wischnevsky (2006), however, suggest that firms should compare and contrast the units that succeeds in generating innovations, with the units that do not. Olsenn, Walker, and Ruekert (1995) suggested that a high level of autonomy contributes to radical product innovation.

Huang, Arundel and Hollanders (2011) states that the third European Community Innovation Survey for 15 countries found that almost half of the informants (4395 innovative firms) did not perform research and development in-house. Veugelers and Cassiman (1999) argued that companies could decide either to make innovations through R&D in-house, or to buy innovations by outsourcing R&D, using consultancy firms, licensing or purchasing other firms.

Tushman & Nadler (1986) stated that successful organizations innovate for today *and* for tomorrow, emphasizing the importance of also focusing on the future when innovating. Dougherty and Hardy (1996) investigated 40 product/service innovations in 15 different very large firms. In most of these firms, innovation occurred, but not because of the system, rather in spite of the system.

Blindenbach-Driessen and Ende (2014) argued that innovation management discipline of traditional paradigm claim that research and development should be organized as a separate department. Blindenbach-Driessen and Ende (2014) also states that personnel have the possibility to develop new knowledge and innovations for a longer period (exploration), unhindered by operational activities by having a separate R&D unit. Many variables should be considered when organizing for innovation; it is dependent on the size of the firm, the type of innovation being produces, whether to outsource or produce R&D in-house or having a separate unit for R&D. This is definitely a research area with broad and contradictory literature. In the next section, different methods for product innovation are described.

2.3. Methods for product innovation

As previously stated in the first section of this chapter, innovation is according to Roger (2003) something that is perceived as new by someone. This study focus on product innovation, so an essential question is how companies can be able to introduce products that are perceived as new. In this subchapter, I will present some tools and methods for product innovation. There are numerous different innovational frameworks, tools and methods that a company can adopt to their company with the purpose of being innovative. The main inspiration for this subchapter are based on the Design Thinking methodology, and the Design Thinking process mainly based on the work of Meinel and Leifer, (2010) and the Hasso Plattner Institute (2010).

Following is a very brief introduction to what design thinking is, followed by the approach used in this framework. The reason this is included, is not because this is exclusively the only approach for innovation, nor necessarily the best approach, but it serves as an example of an approach and provide some of the steps that are typically included in innovation.

Design Thinking is a mindset used to identify and solve complex problems with a user-centered approach, dependent on the context (Brown, 2008; Throring and Müller, 2011; Johansson-Sköldberg, Woodilla and Çetinkaya, 2013; and Leifer and Meinel, 2016). The outline of Design Thinking is not a linear approach to innovation, and as Design Thinking is contexts dependent, not all components of the process are needed in every case. In some situations, you might not need to go through all steps, while in other cases; you might need to repeat the cycle multiple times. Each design process is more complicated than the previous (Brown & Martin, 2015). Because there are several books and articles written about how the Design Thinking process work (Martin, 2009; Carleton, Cockayne & Tahvanainen, 2013; Uebernickel, Brenner, Pukall, Naef & Schindlholzer, 2015; Dorst, 2015, etc.), I only manage to grasp the surface of its content here, but I will write it shortly to inform the reader.

As Design Thinking is much about the mindset, giving a short suggestion of the outline of the personality profile of a design thinker could be useful. Brown (2008) wrote in Harvard Business Review that the personality traits to look for in a Design Thinker are empathy, integrative thinking, optimism, experimentalism, and collaboration. By this, he meant being able to see the world from different perspectives, the ability to identify new information and adjust, always believing there are potential solutions that can be better than the existing, and finally the ability to not just work alongside other disciplines, but also having experience in more than one discipline.

Lockwood (2010) has presented the Design Thinking methodology to include emphasized observation, visualization of ideas, rapid prototyping, fast learning, and continuous analysis of the business. Involving designers, business people, engineers and consumers integrative is the objective of the process. These elements of Design Thinking complement the attributes suggested by Brown (2008) to some degree.

As both Brown (2008) and Lockwood (2010) tapped onto, it is an important factor for a Design Thinker to be able to work in a multidisciplinary team, and maybe even have a multidisciplinary background yourself. Having a team with diverse backgrounds increase team collaboration (Seidel & Fixson, 2013).

In order to create good design, a design process that show the steps that are taken by the designer to get there can be used (Cross, 2000; Yoo, Boland, & Lyytinen, 2006). The Design Thinking process is typically visualized as a five-step process guide (Plattner, Meinel & Leifer, 2010; Ogilvie & Liedtka, 2011; Gestwicki & McNely, 2012) developed at the Hasso Plattner Institute of Design at Stanford.
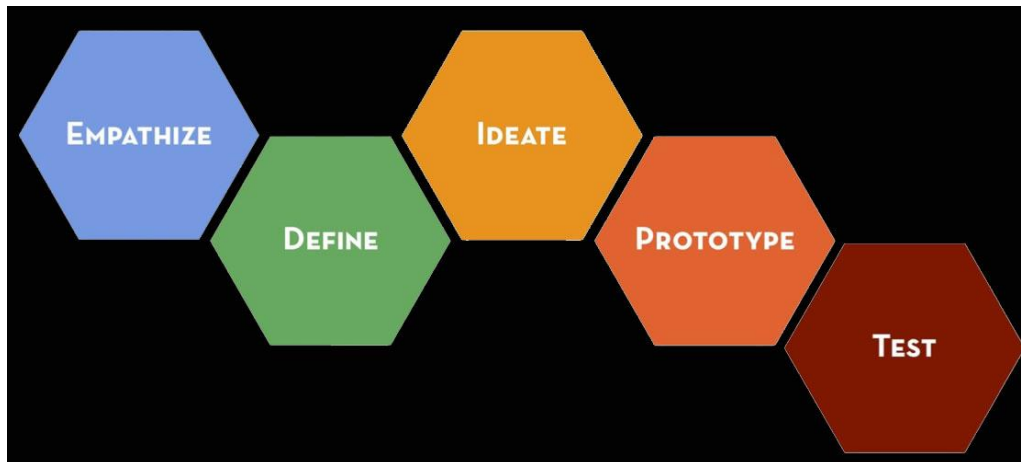
Figure 3: The Design Thinking Process (Hasso Plattner Institure, 2009)

The five steps in the design process are empathize, define, ideate, prototype and test. In order to create meaningful innovations you need to understand users' perspectives and needs, and have empathy towards your design team (Dunne & Martin, 2006). Empathy is the cornerstone of human-centered design, because the designer typically try to solve problems of a particular group of people, and therefore need to learn what is important for them (Adikari, McDonald & Campbell, 2013). Achieving empathy can be done by observation, or actually being in the field engaging with the users (Beckman & Barry, 2007; Brown, 2008; Hassi & Laakso, 2011).

The next step of the process, 'define', is about framing the right problem by bringing clarity to the design space (Hasso Plattner Institute, 2009). Using the information gathered in the empathy phase, defining the challenge you are taking on is important in order to create the right solution (Adams & Nash, 2016). When 'defining', one should create a problem statement consisting of the user, insights gathered from 'empathizing', and their need. By having a problem statement that is well articulated early on in a project – one can always look back at it and check if you are on the right track from where you started.

In the ideation phase the design team should focus on generating ideas and coming up with a broad range of possibilities, both tangible and intangible where the objective is not necessarily creating the "right" idea, but rather the broadest possibility range (Hasso Plattner Institute, 2009; Adams & Nash, 2016; von Thienen, Perlich, Eschrig, & Meinel, 2016.) This can be done in several ways, for example through brainstorming, body storming, and many other ideation methods.

A very important aspect of Design Thinking is testing and building concepts to learn from users and to see if a concept is feasible (Brown, 2008; Razzouk & Shute, 2012; Glen, Suciu & Baughn, 2014; Adams & Nash, 2016). This phase is typically described as 'rapid prototyping', and is one of the reasons Design Thinking differ from other innovation processes. Prototypes can be as simple as cardboards duct taped together to demonstrate a purpose, or to illustrate a concept (Luchs, Swan, & Griffin, 2015). Ideas can be tested and Design Thinkers can learn by doing in a cheap matter (Adams & Nash, 2016). The idea is that it is much easier understand a concept when you can physically hold it and play with it. In the early phase, the prototype should be low resolution and cheap, as of later it might be more refined (Lande & Leifer, 2009; Hasso Plattner Institute, 2009). The prototype should be something the user can interact with, and it should make the concept self-explanatory (Lande & Leifer, 2009; Throring & Müller, 2011).

The last phase of the Hasso Platter Institutes five-step process is testing. This step is simply about testing the prototype you created in the previous phase to gain empathy from the users (Hasso Plattner Institute, 2009). When doing these tests, the Design Thinker tries to test assumptions as well as doing field experiments (Leidtka, 2015). It is important when testing a

prototype or a concept that the designer is not 'in love' with their product. They might learn that some alternative are better, or that the user needed concept modification for a better fit, or just something completely different (Adams & Nash, 2016).

Another important part of Design Thinking that is not so much mentioned here, is Benchmarking and Need finding which can continuously be done throughout the process. Benchmarking is about looking into existing technologies and solutions to the problem you are trying to solve, and this can typically be done after the problem statement has been defined (Lande & Leifer, 2009). Need finding is about figuring out what the 'real' needs of the users are, and this is done by interviewing, observing, creating empathy and building prototypes and testing on users as previously mentioned (Leifer & Steinert, 2011; Aldaz, Steinert, & Leifer, 2013).

(re)Define the Problem
Design never ends

Needfinding and Benchmarking
Understand the users, design space

Test
Learn

Prototype
Build

Bodystorm
Ideate
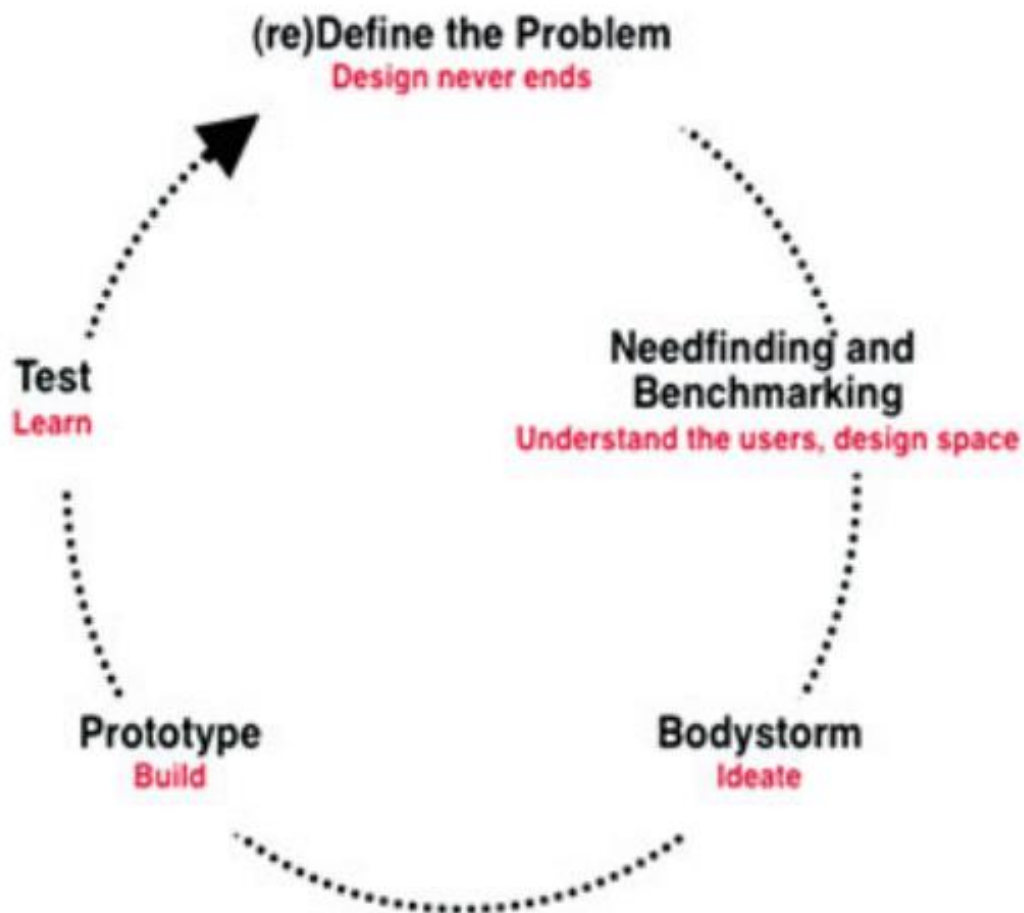
Figure 4: Design Thinking Process Circle (Leifer & Meinel, 2009)

In the picture above, you can see how the Design Thinking process can be portrayed. The reason it is often set up like this, and the reason there is a '(re)' in front of 'define', is because companies typically have to go through this process many times in order get to the bottom of the customer's need, and to create a great futuristic product/solution (Leifer & Meinel, 2009).
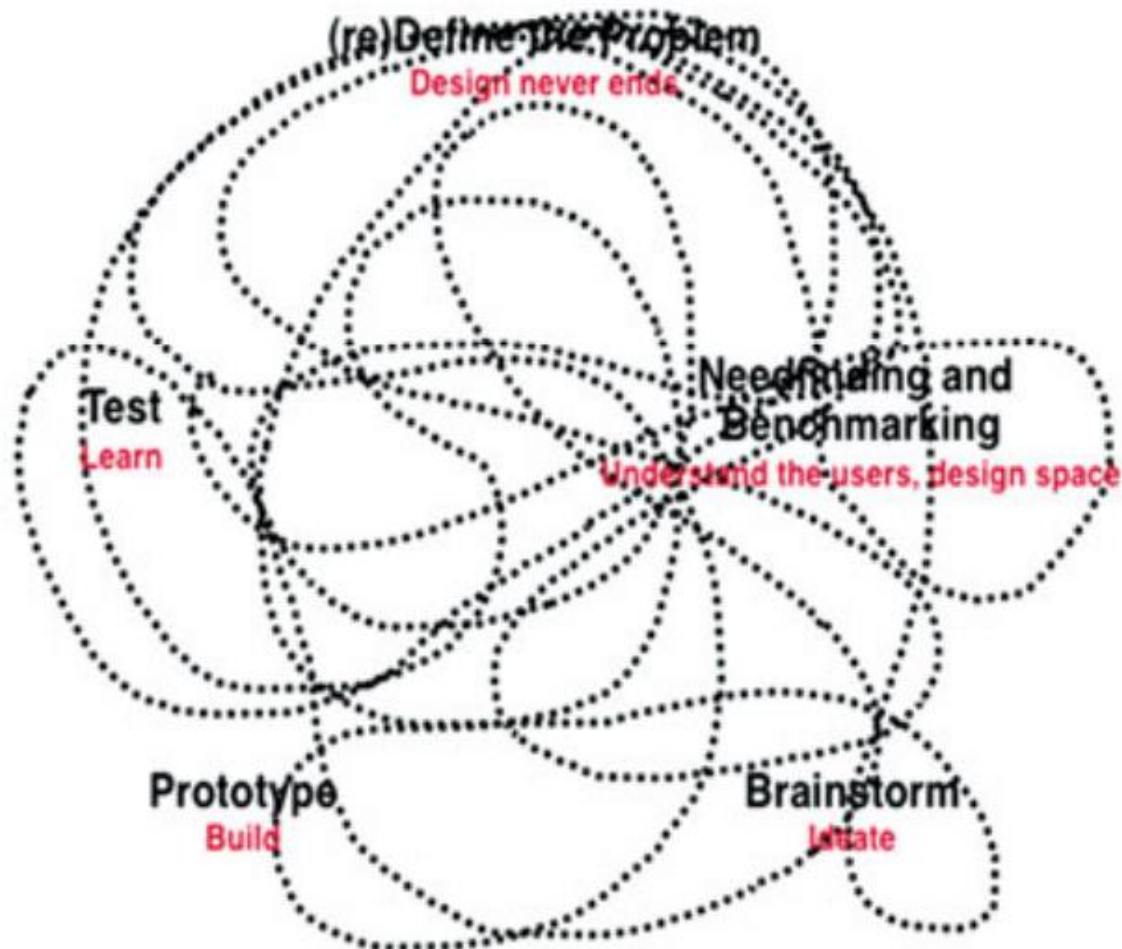
Figure 5: Design Thinking Process Circle (Leifer & Meinel, 2009)

In figure 3, you saw how the Design Thinking process is portrayed as a process, however, in figure 4 you see how Leifer and Meinel (2009) illustrate how the Design Thinking process look in reality. This is one reason why so many academics see the Design Thinking process as very confusing and complex (Hanttu, 2013; Johansson-Sköldberg, Woodilla & Çetinkaya, 2013; Liedtka, 2015). They portray it like this because in reality companies typically do not follow the Design Thinking methodology as a linear process.

From this description of Design Thinking, and the process included, it is easy to say that product innovation include many different phases. This was just one of many different approaches to innovation. Within each step described above, many different approaches can be utilized to gain the desired outcome.

Similar to the Design Thinking process model is the Systems Engineering Vee model. Although visually different, it includes many of the same important aspects. In the Vee model, the company first search for knowledge about the user, before they start building the system or product.
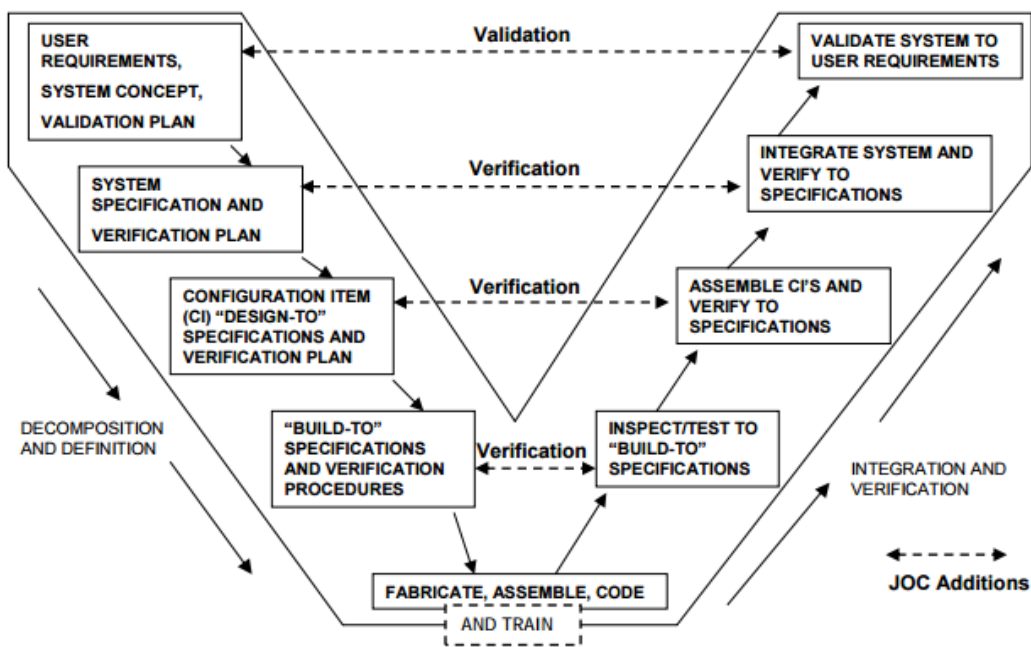
Figure 6: Original Vee Model (Clark, 2009)

Forsberg and Mooz (2005), argue that some of the advantages of the Vee-model is that it emphasize on requirements driven design, testing and integration, and that there is traceability of the requirements throughout the process. There exists several different process models in Systems Engineering, which can be used at different situations. One thing that I have notices as somewhat lacking in the literature investigated, is that there are numerous ways of coming up with new ideas (ideation phase of Design Thinking), however, I do not find it easy to understand when it is appropriate to use one method or another. For the systems engineering Vee-model, the design is configured based on the user and system requirements.

Seemingly typical in product innovation, a problem statement, or a study area have been identified before the firm starts to ideate on possible solutions. The illustrated approaches are theoretical models made by experts within their fields, but how does companies innovate? Do they apply certain models, use certain methods and tools, and stick to those, do they use different methods dependent on the situation, or do they not use any tools or methods for product innovation?

3. Methodology

When conducting research there are many choices that should be made early on to increase the quality, reliability, and validity of the study. Direction of the study should be well thought out and methodological decisions must be made dependent on the phenomenon being studied, what is known about the phenomenon, and the researcher's science ideals. The methodological path the researcher selects shapes the direction of the study. This chapter will describe the methodological choices and outline the process of conducting this study. Choices are based on the purpose of conducting this study. The purpose of this study is mainly to learn how large firms that produce high technological products organize- and what methods they use for product innovation. When making the methodological choices, the time at disposal and resources available was considered.

This chapter is initiated by describing my philosophical standpoint, followed by the research approach chosen and the frame of the study is explained. Further, the strategy for data collection and how the data is analyzed is presented. Finally, it is described how the quality criteria of the study is maintained followed by a methodological reflection.

3.1. Theory development

What science ideals the researcher have are important because they influence how the study is conducted (Savin-Baden & Major, 2013). Science ideals involves the researcher's ontological- and epistemological view which are how the researcher view reality and knowledge. In my opinion, different philosophies can be applied for different studies dependent on the context under study, therefore a situationalist orientation is applied to fit this study (Savin-Baden & Major, 2013).

Ontology holds two extremes on each end which are realism on one side, and idealism on the other side. Realism claims there is a distinction between the interpretation of the world held by individuals and how the world is, whereas idealism claims reality is knowable through the human mind (Ritchie, Lewis, Nicholls, and Ormston, 2013). In this study, the reality is constructed by how individuals perceive the concept product innovation, therefore my ontological view is idealism.

Epistemology deals with the view on how knowledge is created (Savin-Baden and Major, 2013). Ritchie et al (2013) argues that there are two main epistemology stances which are positivism and interpretivism. Positivism holds that natural science methods are appropriate for social sciences and that you can find law-like regularities. Opposite is interpretivism claiming methods of natural sciences are not appropriate and that the social world is not governed by law-like properties. I believe that knowledge can be created in different ways, and the appropriate method depends on the context under study. For this study, I see it more fit to explore and understand the social context through the companies under investigation and their perspectives. Therefore, an interpretivism epistemological stance is taken.

How knowledge is acquired is also an important aspect of the methodological choices in a study. The researcher must choose between an inductive or deductive approach. With an inductive approach, the researcher look for patterns obtained from observations of the world, whereas in deductive approach hypothesis or propositions are reached theoretically (Ritchie et al, 2013). The purpose of this study is to gain knowledge about how large companies that produce high technological products organize for-, and what methods they use for product innovation, which is generating theory from data. Because I am not testing theory through hypothesis or propositions, but rather generate theory from data, an inductive approach is chosen.

3.2. Nature of research question

Yin (2014) argue that you should decide between three types of research designs that should match the research question. These are descriptive, explanatory and exploratory. For this study, exploratory design is the best fit because it deals with investigating little understood phenomena and to discover or identify categories of meaning. Typically for exploratory design is that the research questions are what or how questions which fits well to this study. Exploratory design is typically also used with an inductive approach which is selected for this study.

3.3. Research approach

Based on the philosophical stance taken and the context of the research, the desired approach for this study is qualitative research. In qualitative research the researcher aims to investigate the meaning of social phenomena as people experience it (Malterud, 2001), which is in line with what is planned for this study. If what is under study is not well defined with a collective understanding, a qualitative approach is natural. Because the purpose of this study is to investigate how large companies that produce high technological products organize-, and what methods they use for product innovation, it makes sense to choose a qualitative approach. Qualitative research is typically seen as an inductive approach, which is the chosen approach for this study. Typically, research questions in qualitative approach begins with 'how', 'why', or 'in what way' questions and the research question for this study starts with 'how' (Yin, 2014).

3.4. Strategies of inquiry

Conducting research can primarily be done in two ways, either studies where data is collected and analyzed (field research) or pure theoretical studies (desktop research). Based on previous stated information, it is obvious that this is a field research. In qualitative research, the data can be collected in many different ways, such as different kinds of interviews, experiments and observations. The choice for this particular study was mainly guided by the context under study, and the fact that there is a resource constraint on time for a master's thesis. The interview method was chosen as a qualitative approach to gather information through in depth interviews with intentionally selected informants. The description of the selection criteria is explained later.

There are numerous different research strategies, but Savin-Baden and Major (2013) outlined 10 different strategies which are pragmatic research, grounded theory, case studies, phenomenology, ethnography, action research, narrative approaches, art-based approaches, collaborative approaches, and evaluation. Case studies have been selected, and it is suitable as strategy because the phenomenon under investigation is closely linked to the context. Case studies are typically used when an organization, a group or an individual are the unit of analysis (Yin, 2014), which is the case for this study.

3.4.1. Case study research

Yin (2014) argue that case study is preferred if the researcher has little control over events, if the focus is on contemporary phenomenon within a real-life context and if "how", or "why" questions are used. I did not have control over the events as I could not even know how the companies were organized or what methods they used for product innovation and did not have any intentions or authority to influence or control them in any way. Organizing and what methods that are being used for product innovation is in my opinion a contemporary phenomenon, and studied through people's perceptions of the terms in their companies, it is also a real-life context. As mentioned earlier, the research question also starts with "how", and according to Yin's (2014) criteria's, case study is preferred for this study. In order to do this case study research, the process shown in the figure below is used. This is Yin's (2014) model where it is stated that a case study research is a linear but iterative process.
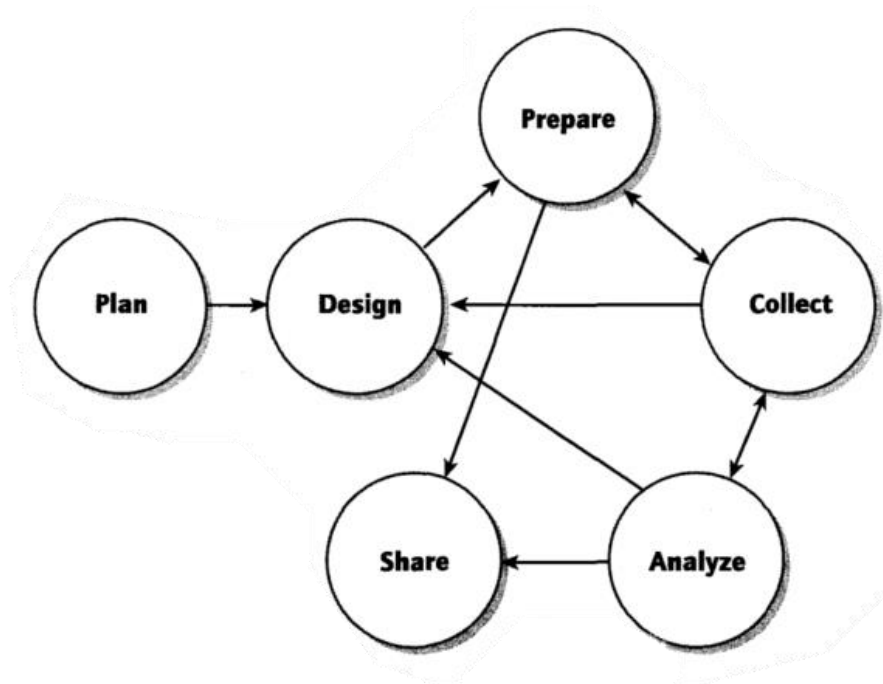
Figure 7: Process of case study research (Yin, 2014, P. 1)

One of the most challenging social science strategies is case studies, and the methodological path starts with a thorough literature review (Yin, 2014) as shown in the previous chapter. One of the strengths of case studies is that they can deal with a wide variety of evidence such as documents, artifacts, interviews and observations. This will be described more in detail in chapter 3.5. A research design has the purpose to help avoid that the evidence does not answer the research question (Yin, 2014).

Case studies have been seen as a less desirable research inquiry than others, and Yin (2014) argue that this is because too many times this is because the researcher are sloppy, biased, or not followed the systematic procedures.
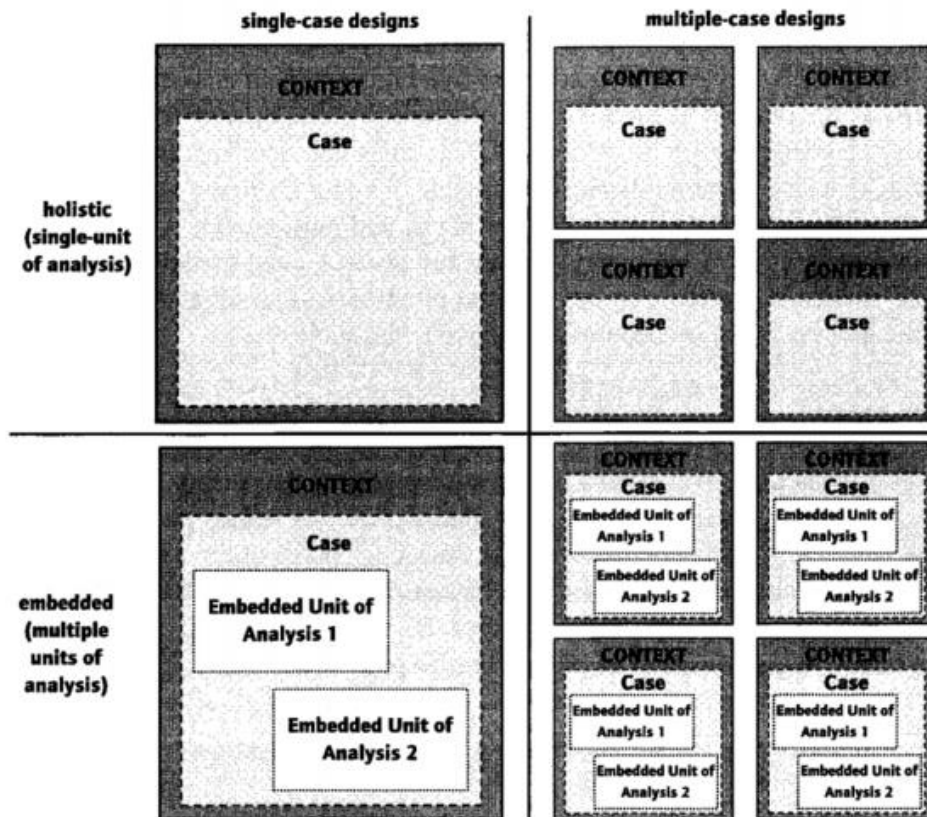
Figure 8: Basic Types of Designs for Case Studies (Yin, 2014)

There are four different major types of case study designs following a 2 x 2 matrix (see figure above), and Yin (2014) claim that most multiple case studies likely are stronger than single-case studies. This is also one of the reasons why a broad multiple case study was chosen for this

study, as five different companies (cases) were investigated. For this study, there was only one unit of analysis, namely the R&D / product development/innovation department. The reason I chose this as the unit of analysis, is because I do not focus on other parts of the companies than the department where the early stage of product development/innovation happens. This left me with a multiple holistic case design. Some of the advantages with multiple-cases over single-case is that the evidence often is considered more compelling, and the study is therefore more robust (Yin, 2014). Multiple-cases however, do require extensive time and resources. Each case chosen must be selected to either to predict similar results (literal replication) or predict contrasting results for anticipatable reasons (theoretical replication) (Yin, 2014). Any multiple-case design should follow a replication logic where the investigator chooses cases carefully. How cases were chosen will be described in subchapter 3.5.

In the preparation stage of the case study research process outlined earlier, made by Yin (2014), there are some traits associated with the skills required of the researcher. The researcher should be able to ask good questions and interpret the answers, be a good listener, be adaptive, have a firm grasp of the issue being studied and unbiased by preconceived notions. Although this is the first case study research I have conducted that is of this size, I have done my very best to be a good investigator and consciously think about these skills prior to interviews. This will be further discussed in coming sections.

3.5. Research methods and data analysis

As mentioned in the previous section, data can be collected in many different ways when conducting a case study research. Common for the data in qualitative research are that they are non-numeric but rather words, pictures, drawings, movies or sound. For this study, the main data collection tool is in depth interviews, but documentation will also be used for extra information. Documents can be relevant for case study research as it can provide valuable data. Documents are typically personal documents, written reports, formal studies or news clippings (Yin, 2014). In this particular study, documents were mainly used to screen which companies to investigate and to generate general knowledge about them to see how relevant they were for this study. Some weaknesses argued about documents is that the research can be selective or they can be colored by the person who wrote them, and hence lead to research bias.

However, for this study, documents were only used for general information about the investigated companies and not as part of the analysis, and there should be no reason this should lead to any bias.

3.5.1. Interview

As mentioned earlier, interviews are one of the most common data gathering methods for case studies. Because this study uses a qualitative research approach, in depth interviews is a good way to gain knowledge about the phenomenon under study. This is the primary method to gather data for this research study. In depth interviews can be a good way to gather information when there is little prior information in this field, because the interviewee can ask follow-up questions to allow the informant to elaborate.

As previously stated, there are certain skills a case study researcher should be aware of to conduct good studies without bias. These skills are asking good questions, be a good listener, be adaptive and flexible, have a grasp of the issue being studied, and unbiased by preconceived notions (Yin, 2014). It is important to be able to ask good questions and interpret answers fast, because specific information gathered is not predictable. This skill is also linked with the following skills. It is important that the researcher is a good listener and not trapped by own preconceptions. Being a good listener means being aware that there might be something "between the lines" of what the informant say and when the informant reconciles an incident, the researcher should hear the exact words, capture the mood, and understand the context (Yin, 2014). By recording all of the interviews conducted, I could focus on being a good listener by also noticing other factors than what words are being said, but also grasp onto emotions shown through body language, voice pitch etc. Being adaptive and flexible as a researcher is important in order to adapt if unanticipated events happens. The researcher must remember the original purpose of the investigation, but be willing to adapt. This is a natural pursue when a semi-structured interview with open-ended questions is conducted, as the case under investigation can give completely different answers than anticipated. It is also important to have a firm grasp of the issues under study so that important clues or desired or accepted deviations are not missed (Yin, 2014). Finally, it is important that preconceived notions do not

bias the researcher, not even those coming from theory. This means that the researcher must be open for contrary findings.

In consideration of human subject protection, all the interviewed informants first received a formal invitation with information about the study and the interview, that the study was approved by the NSD (Norwegian Centre for Research Data), that personal information would be confidential and how it would be handled, and that their business details would be coded. Yin (2014) argue that these are important factors, and that the researcher should gain consent from all persons involved in the case study. All informants were also asked if I could record the interview, and transcribe this afterwards, and that all participation was voluntary.

A lot of time was spent to create questions that was planned, well-articulated, non-leading, and open-ended. These questions were created based on the theoretical foundation of the previous chapter, and as a way to be able to answer the research question, and then discussed and refined after guidance meetings. The plan was also to do a test-interview with a relevant company that I thought would possess valuable knowledge about my study, and hence could provide good feedback on any changes that should be made to the interview guide. However, as time is a major issue when conducting a master's thesis in four and a half months, I was not able to make this interview happen due to busy business schedules of the company, so I had to move on. When creating the questions, it was important not to make leading questions, as some informants might answer those questions they think the researcher would like to hear. When conducting the interviews, it could be important to try to establish some sort of trust or connection to increase the likelihood of honest answers. In order to prevent the interviews from being too stressful and as comfortable and normal setting for the informants as possible, they could decide the place and time for the interview, as well as all of them received the interview guide prior to the interviews. This was done so that they would feel at ease, as well as they could prepare for the questions. For this study I do not think any of the informants were dishonest, as questions were not personal and they would not have anything to gain on being dishonest.

There are several types of interviews, but Savin-Baden and Major (2013) argued for four types which were structured, semi-structured, unstructured and informal. In a structural interview, the researcher follows an interview protocol were all the same questions are asked exactly the same for all informants. For semi-structured interviews, there is also an interview protocol with a set of questions to ask, but the researcher can also ask follow-up question and step away from the script to investigate interesting comments or arguments. In an unstructured interview, the researcher knows the topic well and have a plan, but there is no interview protocol. In informal interviews, interview protocols are not used, but the researcher interview people in the field of study with knowledge in an informal matter. Semi-structured interviews were conducted for this particular case study research.

Yin (2014) argue that it is essential to have a case study protocol when conducing a multiple-case study and that it increases the reliability of the case study research. A case study protocol was created for this study. The protocol started with background information about the project as a statement that was sent to all informants in an "invitation" as mentioned in section 3.5.1. Because I wanted to interview the informants in their everyday situation, all interviews except one was held at their normal workplace so that I did not have control over the data collection environment (Yin, 2014). The last interview was held at the cafeteria at my school upon wish of the informant. When being in the field, I also made sure I had a fully charged recording device, pen and paper, personal computer and the interview guide and information about the study.

Opposite from survey form, Yin (2014) states that the case study questions is more directed towards the investigator than the interviewee, as they serve as a reminder about what information that needs to be collected and why. The interview protocol started with personal information about the interviewee like their position in the company, how long they had worked there and how long they had worked with innovation or development etc. The reason these personal questions were included in this study was to confirm that they had the desired knowledge set and ensure validity. The next part was a more general part where the informants was ask to describe how they would define product innovation, in order to learn how they viewed the topic. Then the next part of the interview protocol was divided in two parts, where the first part focused on how the companies was organized for product innovation, and the

second part what innovation methods or tools they used to generate ideas or product innovations. Questions were developed as the theory was being reviewed, and refined to questions where I thought the data collection would generate good and deep information about the phenomenon under study. Although this thesis is written in English, all the interviews were conducted in Norwegian. The reason is that all the persons interviewed were Norwegian so it would be a more natural setting for the informants to do it in Norwegian. The interviews lasted between 45 minutes and 100 minutes. The reason it varied quite a bit, was that some informants were more outspoken and gave longer answers to the open-ended questions, as well as presenting some data in more depth than others. This could have been due to some of them having more knowledge about the phenomenon under study. The interview protocol can be found in the appendices, both in Norwegian and in English.

3.5.2. Selection of informants

In this section, a description of the selection criteria used to select cases and the population of this case study is outlined. Informants have carefully be selected based on their relevance and how well I thought they could provide relevant information to this study. In this study I wanted to investigate how large companies that produce high technological products organize for product innovation, and what methods or tools they were using for product innovation. The possible companies to investigate then would be large companies that produces complex products. Chandy and Tellis (2000) used the scaling to call a company large if it had 2500 or more employers, this is also the scale I was looking at when I was selecting cases. To judge whether or not a company is producing high technology- or complex products is somewhat subjective, however, I defined it as a company producing complex products in the sense that it is high cost technology with long development time requiring high technical competence. The desired persons to interview from the different companies were people with knowledge about the areas of study, preferably leaders of research and development, innovation etc. With these criteria at hand, it could be somewhat challenging to conduct enough interviews in the short amount of time available. Because I had attended various technical seminars and courses, I had a bunch of relevant contact details. I also received help from a professor at University College of Southeast-Norway to get in touch with relevant persons. Savin-Baden and Major (2013) argue

that the data collection should continue until there is little or no additional information gained from additional cases which is called saturation.

After I had conducted in depth-interviews with five different companies, I felt that saturation was reached. Four of the organizations worked in different industries, whereas the fifth company was operating more as a consultant company taking on product innovation- and development projects from all of the other interviewed companies among others. This company and the fourth company did not have more than 2500 employees, but fairly close. The other companies was either standalone company with more than 2500 employees or part of a bigger concern. The reason I chose to also interview company five, was that I believed they could provide different but good knowledge both for my study, but also about the other companies. Information about each company was presented in chapter 1.

3.5.3. Data analysis

All interviews were recorded and transcribed. Transcription means converting speech to text, and is a very time-consuming process, as it took more than double the amount of time to transcribe than the length of the interviews. One of the benefits of transcribing the interview data is that you can draw direct citations from the interview, but it also strengthens the research credibility. It was just one of the interviews that I was not able to fully transcribe, as it was too much background noise. However, this was something I noticed before the interview started, so notes were taken during the interview, and data was transcribed as best I could afterwards. Direct citations were only used where I was fully certain about the exact words said. After all the data was transcribed, it was put into the qualitative data analysis tool NVivo for coding and systematical categorization of data to prepare for analysis. When analyzing data of qualitative studies, the strategy is to reduce the data by using coding as a tool. When coding, I went through one interview at a time, and added more 'nodes' in NVivo to categorize the data. The data was mainly coded to terms that were used in the literature review and the interview protocol. All the data collected were only accessible by me, and was stored on my personal computer protected by password. When analyzing the coded data, I went through all the answers from the informants on each of the different topic (codes), and then compared the answers to theories presented in the literature review.

3.6. Evaluating research with quality criteria

To assure quality of the study and that the information provided is unbiased and good, quality measures such as validity and reliability must be described. Validity describe the data gathered relevance to theory and research question, whereas reliability describes the dependability of the data (Ringdal, 2001). It has been discussed among social science authors whether or not reliability and validity should hold a place in qualitative research study, but Jonnson (1999) argues that it is important to bring up the significance of qualitative research and what strategies could be used to increase the validity of the study. Validity is whether or not the research is plausible, trustworthy, and defendable (Johnson, 1999). Although it is a disputed topic, I am in belief that validity and reliability are essential to evaluate and assure quality in the study. In the next sections the terms validity and reliability is discussed.

3.6.1. Validity

Validity involves measuring what was intended to measure. There are some threats to validity, and Johnson (1999) points out that the researcher must look out for research bias, which can be about finding what you wanted to find. Research bias can typically derive from selective observation and recording and allowance of personal views to affect the interpretation. One way of avoiding research bias is called reflexivity, where the researcher actively reflect on own potential biases. Johnson (1999) mainly discussed three types of validity in his article, namely theoretical-, descriptive-, and interpretative validity, however, he also added two types common for quantitative research but of interest for qualitative researchers also, which are internal and external validity. These types are covered in the following sections.

3.6.1.1. Descriptive validity

Two important questions for descriptive validity are whether what was reported as taking place in the study actually happen and if the researcher reported what he heard and saw accurately (Johnson, 1999). So this refer to accurate description of the reporting in regards to describing settings, events, places and times. One way of obtaining descriptive validity is by doing investigation triangulation which could be done by having multiple observers. Because I was conducting this study alone, and did all interviews and analysis alone, the descriptive validity

will not be as credible and defensible as if there was multiple researchers. However, body language, shown emotions etc. observed during the interviews are not emphasized in the analysis, but was rather used to ask good follow up questions etc. When conducting the interviews, a few key points was down written during the interview if there was an incident or something regarded as special happening, and right after each interview a short summary was written. These were compared when doing the analysis. I also focused on transcribing the interviews shortly after the interviews, and not having too much time between each interview, however they did not happen as close as I wanted too because it was difficult to arrange meetings with all of the companies. I do however feel that the descriptive validity was preserved, as interviews was recorded and transcribed to be sure all data analyzed was exactly as said by the informant.

3.6.1.2. Interpretative validity

Interpretative validity refers to "the degree to which the research participants' viewpoints, thoughts, feelings, intentions, and experiences are accurately understood by the qualitative researcher and portrayed in the research report" (Johnson, 1999, p. 285). In other word, understanding the mind of the participating informants in the study and presenting these inner words accurately. One strategy that Johnson (1999) states, that I frequently used during interviews was participant feedback, where I would at some points repeat some main points the participant stated, and my interpretation of that to see if my interpretation was right. Another strategy for interpretative validity is by using many low inference descriptors, so the reader get the exact words of the participants and can experience for themselves the participants perspectives. As all of the interviews were conducted in Norwegian, the citations are direct translation into English and should not have any special inference. Another point here is that I let all the participants describe their definition product innovation, in order to get into the mind of the participant on how they viewed the topic before going more into depth.

3.6.1.3. Theoretical validity

Theoretical validity is described by Johnson (1999) as the degree the collected data consist with research results. It deals with how well theoretical explanations developed from a research study fit the data. If it fits well, it is credible and defensive. This was also one of the purposes of

this study, to compare the data from this study with existing literature in the field. Johnson (1999) discussed different strategies to increase the theoretical validity, and the strategy called peer review, where the study was discussed with people not directly involved with the study, was frequently used with classmates. Theory triangulation was also used as multiple perspectives and theories was used to help interpret and explain the data. Other strategies that could have been used are extended fieldwork, investor triangulation, negative case sampling, and pattern matching for increased theoretical validity and hence more credibility and defensibility. However, as time and resource is a major limitation for a master's thesis, I was not able to use all strategies, but still feel that I was able to maintain theoretical validity.

3.6.1.4. Internal validity

The extent to which a researcher is justified in concluding that an observed relationship is normal is what Johnson (1999) describe as internal validity. In other words the researcher should justify any claims of cause and effect relationships in the study. Cause and effect relationships is not commonly used in qualitative studies and was not examined in this study because an exploratory approach was used, and I did not intent do test any hypothesis. To increase internal validity, Johnson (1999) argued for 12 different strategies that could help obtain internal validity, namely the researcher as detective, extended fieldwork, low inference descriptors, theory triangulation, method triangulation, investigator triangulation, data triangulation, participant feedback, peer review, negative case sampling, and pattern matching. As earlier mentioned, we have made use of low inference descriptors, theory triangulation, investigator triangulation, and peer review. As previously stated, theory triangulation, peer review, and low inference descriptors were used. Additionally, the strategy called "the researcher as detective" was used by having a critical view on decisions made and findings throughout the study, and was something I tried to focus on. Data triangulation was achieved by collecting data from five different informants that differed in terms of size and enterprise as well as some general information that was gathered about each of the companies. Based on all this information, I believe that internal validity is maintained for this study.

3.6.1.5. External validity

The external validity describe to what degree findings in this study can generalize to other persons or settings through replication (Johnson, 1999). Generalization is typically not the main purpose of qualitative studies as the sample is seldom random, and it is not the desired outcome of the researcher (Johnson, 1999). Johnson (1999) argue, based on Stake's (1990) work, that a rough generalization can be made from qualitative data based on similarity. Generalization is more justifiable the more similar the phenomenon under study and the phenomenon wanted to generalize. As mentioned shortly in subchapter 3.4.1., cases should be selected either by theoretical- or literal replication logic. For this study, the four first cases was intended to be literal replications as I thought they would provide somewhat similar results because of their similarities, whereas the last case I thought would have contrasting findings, and hence a theoretical replication was used. The literal replication logic is that the more frequent research findings are applied to different informants, the more confidence we can have that the findings can be generalized beyond this study (Johnson, 1999). Because this study used a multiple holistic case study design with five different cases, whereas four of them was with literal replication logic, I believe that the external validity is maintained.

3.6.2. Reliability

"Reliability refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions. It provides evidence about validity and also tells us about the usefulness of the particular research strategy used" (Hammersley, 1992, p. 67). This meaning that the study should be trustworthy, reliable, and that there should be consistency and repeatability of the research procedures used in the study. There are several strategies that can be used to strengthen the reliability of the study. Sound recording interviews, explaining procedures for data collection, and presenting large extracts from the data are strategies that Ryen (2002) suggests among others. These mentioned strategies was used for this study to increase the reliability. All interviews was recorded and transcribed as mentioned earlier, data collection procedures have also been described and in the data analysis chapter, citations are used to keep a low level of inference. For these reasons, I believe that reliability have been maintained for this study. To increase the reliability of the

study, I could have had more than one researcher to categorize and compare the data for analysis. A study can be reliable without being valid; however, it cannot be valid without being reliable.

3.7. Ethical considerations

Ethical considerations have a particular resonance in qualitative research studies because the in-depth, unstructured nature of the research and that it can raise issues that are not anticipated (Ritchie et al, 2013). As mentioned earlier in the chapter, all participants of the study received an invitation document that outlined description of the study, how the interview would happen, that the study was approved by Norwegian Centre for Reearch Data, that personal information would be confidential, that sensitive information would be coded, that the study was voluntary, that the interview would be recorded if it was OK, and how the data would be stored. All participants also received this document when I met to the interview them, for them to sign off, and where I once again asked the participant if it was OK for them if I was recording the interview. All of the participants signed the declaration of consents, and agreed to record the interviews.

Anonymity and confidentiality should be given special thought, and made very clear for the informants (Ritchie et al, 2013). Anonymity refers to the informants not being known outside of the research group, and for this study, it was only me that had access to the names of the persons being interviewed. This was also something the informants were informed off beforehand. This is why the name of the persons or the companies are not included in this study, but rather the position the person holds in the company, and the industry the company operates in. Confidentiality means to avoid comments in the report to identified participants (Ritchie et al, 2013). By this, the researcher should not directly (comments linked to a name) or indirectly by referencing to a set of characteristics that might identify the individual. This is something I was very clear about before I started gathering data, and also made sure described for the informants so they would not be scared of saying something that could harm them or their company. This is also why the transcripts and audio records were stored separately from the document with personal information, and the informants names were not written in the transcripts, but rather just the first letter of their name. For some of the informants, just the

fact that they worked for that particular company was very sensitive information for them, and something they did not want people to know, this is also another reason why I wanted to be professional and aim for a high degree of ethics by preserving anonymity and confidentiality as wanted. The last ethical consideration for this study was avoiding plagiarism. Many different references have been used for this study, and for direct citations, the author name(s), year and the page where the citation is extracted from is provided to ensure other people easily can find the original citation.

3.7. Reflection on methodological choices

In this last section of this chapter I will reflect on some of the methodological choices taken throughout the study, and what choices could have been made different to make the study more credible, reliable, valid, or generally just better.

For this study, a holistic multiple case with an inductive approach and an exploratory design was used as a qualitative method to gather the data. There were many choices to be made, and the choices taken and some possible alternative approaches have been described previously in this chapter. There are some choices that could have been taken prior to this study that could have improved the study in some ways. For example, if I had a research partner for this study, the reliability and the internal validity of the study could have been improved because we could compare categorization in the analysis and do investigator triangulations. There are many other choices that could have been taken in order to increase validity and reliability of the study, but many of them were not possible for me to obtain because of the major limitation of time and resource of this study. Some of these choices could have been to do single case study with the advantage of longitudinal case where I investigated a company over several periods (Yin, 2014). Dyer and Wilkins (1991) also argued that the depth of the study is likely to suffer from multiple cases. I also could have tried to attend some product innovation session to observe how they were organized and what methods were actually being used. However, this could ultimately also cause the Hawthorne effect, where the observed people change their behavior because they know they are being watched. I do however feel that the methodological choices taken in this study was well thought out, argued and described for throughout, and that the cases chosen for this study set the basis to gather both depth and width data for analysis.

4. Data analysis

In this chapter, the data obtained through the in depth interviews are presented and analyzed. The purpose of analyzing the data is to compare it to the theory presented in chapter 2, look for eventual significant findings, and attempt to answer the research question for this study. The research question for this study is:

"How do large firms that produce high technological products organize for product innovation, and what methods do they use to promote innovative behavior?"

Five in depth interviews were conducted in five different large firms that produce high technological products. Some information about the informant's position, how many years they have worked for the company under investigation and how many years they have worked with innovation in general is provided in the table below. Based on the information about each company provided in chapter one, informant 1 works for company 1, informant 2 works for company 2 - informant 5 works for company 5 etc.

	Position	Years in this company	Years working with innovation
Informant 1	R&D Engineer	2	15
Informant 2	Manager Technology Group	15	25+
Informant 3	Leader Continuous Improvements	10	25+
Informant 4	Senior System Developer	7	22
Informant 5	Program Manager and Sales Manager	5	28

Figure 9: Background information about informants

For all the conducted interviews, a standardized interview guide with the same set of basic questions was used to ensure comparable results and proper data collection. The interview guide was created based on the theories presented regarding product innovation, type of innovation, firm size, innovation methods and organizing, and to answer the research question. The interviews did deviate away from the guide as it was semi-structured interviews, however all informants were asked the same questions.

Full transcripts are not included in this study as it was too much data (55 pages) to present in a readable matter. Selected citations from the interviews are presented in the analysis so the reader can evaluate some of my interpretations, and create a more personal relation to the informants. Direct citations will not be provided for all informants for every topic, as that would be too much to include here. In order to protect the identities of the informants and potentially confidential information about the firms, information that could possibly reveal the informant or the firm are replaced with "NN". This should not have an important effect on the context.

The data collected is divided into analogically parts in the same order as in the theoretical chapter. The informants' subjective perception of the concept product innovation and their view on how firm size affect innovation is first reviewed to understand how the informants view the concepts. Secondly, the informants' perception of what type of product innovation they create and focus on are presented, followed by how the firms are organized for product innovation. Lastly, what tools and methods the companies use to promote innovative behavior are presented.

4.1. Product innovation

As stated in the literature review, innovation is a term that researchers have defined very differently, and it consists of many different aspects. Because this study mainly focus on product innovation, I wanted to understand how the investigated informants defined the term, and what they associated with it, to make sure we had a common understanding of the term.

As all of the informants had many years of experience working with innovation, and it seemed like all of them had a firm grip and an opinion on what product innovation is. Here are the definitions provided by informant 2 and 3 when asked to define product innovation:

> *"That is the thousand kroner question. We separate between two main categories. One of them is product improvement, you can find a solution that makes the product both better functionally and cheaper to produce. That is one form of innovation. Then you also have innovation in a way where you come up with new product and services that are not currently existing. "*

Informant 2

"It is about that a business have an idea, or buys an idea, or continuously develop a product further, and not just come up with the idea, but manage to bring the product to the market to earn money on it. Then it is an innovation. It is not just about being creative; innovation is more than being creative. You have to bring the idea further also"

<div align="right">Informant 3</div>

Comparing these answers provided by the informants with the literature, we can see that their response are fairly similar to Rogers' (2010) definition that a product innovation is an object perceived as new by somebody. We could also see that informant 2 distinguished between two types of innovation, and by how it was described, similarly to what Chandy and Tellis (1998) called incremental and product innovation. Informant 5 also emphasized that product innovation is not just about creativity, but actually bringing it to the market and make money on it, which is similar to what Roberts (1988) and Decelle (2004) stated. There was no significant difference in how the different informants defined product innovation, and it seemed like they all had a firm grasp of the concept. One remark here though was that Informant 4 stated:

"For me innovation is actually a little bit like a 'fluffy' word, actually. Because in all the years we have been doing development, coming up with something new is fairly naturally. It is natural for an engineer. That is what drives the operations, you know. We do what is called development, where you add functionalities. (…) But when it comes to innovation, then it is something about creativity and coming up with something totally new (…) It might just be because I have always worked with development of some sort, so innovation becomes a bit "airy" (…)"

<div align="right">Informant 4</div>

This is an interesting finding. As literature suggest, there are lots of different interpretations on what innovation is, but as this informant presents that he perceive it as a 'fluffy' and 'airy' concept, and suggested it might be because he was an engineer. It did however seem like he clear view on what product innovation was based on the other information he provided.

4.1.1. Summary

When interviewing the informants, all participants were able to provide several elements mentioned in the literature as typical traits of product innovation, and it seemed like all of them had a firm grasp of what it is. Some of the traits that was mentioned about innovation from the informants was different types of innovation, and that it is something that is perceived as new, and that it does not just involve having an idea, but bringing it to the market.

4.1.2. Firm size

In this section I wanted to investigate the informants' opinion on what effect firm size have on the firm's innovative capabilities. Because all the firms investigated were large (or almost large), I had an assumption that they would have an opinion of large firms based on personal experience, and I wanted to see how they reflected upon how smaller firms' innovative capabilities compared to large firms. Following are the answers of informant 2 and 5 when they were asked if they believed that firm size had, and if so how, an effect on their ability to create product innovations:

"Whether it is a good thing or bad thing is up to somebody else to say, but a small firm is more 'light-footed' and can more easily turn around maybe. And not so locked down in procedures, so you can have more breakthrough in shorter time. But in large firms you have generally all the competency disciplines that you need. You have a large organization with a large financial strength so you can put some power behind what you are doing. (…) and out of over 2000 heads we have more ideas to choose from. But I think the most important to pull an innovation into a product is that you have finance behind. (…)"

Informant 2

"Yes because with size comes structure. So I believe that the most innovative.. the potential to be innovative is greater for the small than the large firm. I do not say that the large is not innovative, but when you operationalize the operations more, then you hinder innovative thinking. (…)"

Informant 5

The informants also described many of the points that Damenpour and Wischevsky (2006) made about large and small firms. For instance, informant 2 states that small firms can more easily turn around, which was one of the points found in the literature in order to be more innovative. Informant 2 also states that larger firms have more innovative potential by having more heads to create ideas, more skilled workers and greater financial backing. This is also pointed out in the literature as some typical traits of why larger firms can be more innovative. However, informant 5 believed that smaller firms have more potential of being innovative because larger firms tend to get more structures that prevents innovative thinking. This is in line with theory of inertia that Chandy and Tellis (2008) wrote about. Informant 1 had somewhat the same answer as informant 2, stating that larger firms have the advantage of financial backing, while smaller firms had the benefit of flexibility. Informant 4, however, answered that he believed that small firms had to be creative, and at least do something innovative to get started, but then as the smaller firm would grow larger, it would focus more on maintenance rather than innovation. Informant 3 did however stated that he thought it was more about what industry the firm was operating in, than the size of the firm. He stated that this was because he was in the aerospace industry where there are extreme requirements and precision.

4.1.2.1. Summary

Some of the informants pointed out the advantage large firms have over small firms in terms of financial backing, and some also stated the negative factor for large firms that they tend to be too structured, and then suffer from theory of inertia. Some of the informant also stated that small firms are typically better with radical product innovation because they can turn around faster and be more flexible, but have the negative effect of typically not having the financial backing. As we also can see from the answers from the informants of this study, is that there is inconsistency in the opinions in regards of whether firm size have a positive or negative relation to innovation, which was the same conclusion that Camisón-Zornoza et al (2004) provided.

4.1.3. Types of product innovation

The literature review revealed that there are different kinds of product innovation, and Chandy and Tellis (1998) presented four different types. For this study, I wanted the informants to distinguish between these different types of product innovation, and let them reflect on what types of product innovations they focus the most on, if they do different kinds, and if they could provide examples of products that they had produces that was either incremental or radical. Even though the model presented by Chandy and Tellis (1998) separated between four different kinds of innovation, the focus for this study have mainly been between the two opposites – incremental and radical product innovation. This was not intentional, but I assume that these terms are what the informants was most familiar with. When I was doing the interviews, I showed the informants Chandy, and Tellis' model and described it. Then I asked if they focused on different types of innovations, and if they could provide an example of both. Following are the answers from informant 1 and 4:

> *"(…) At this point, we do not have organization to operate disruptive innovation. We probably lay in the area that is called incremental/disruptive. It is like five levels of innovation, so yes. We probably lay on level two, almost three'ish. Five is like. Nobody knows what disruptive innovations should be used for. A good example of a level five innovation was that time when the laser was invented. Then it was many that said it was fine, you can concentrate it out, but what can it be used for? And now, almost 100 years later, what is the laser used for today? Almost everything. Right. So it is an innovation that is way out. Long before its time, and therefore it is typically an innovation that very often 'fall in oblivion'. It is something I find very interesting. Something I like to do, searching a little in old patents and old ideas. Because then there could be something that is sitting there and wonder like the day they came when nobody understood what it should be used for. But today with the technology and possibilities of producing etc., then it is suddenly a gold mine! (…)"*

Informant 1

Informant 1 stated that there are five different types of product innovations, and meant that disruptive innovation was the additional type of Chandy and Tellis' (1998) model. Disruptive innovation is the same term as Christensen (2013) used, and as informant 1 say, it is typically before its time, and that people do not know the use of it at first and provides an example of

what a disruptive innovation is. Informant 1 describe further that their organization mainly produce incremental innovations because of the lack of capital in the automobile industry, so most companies operate safe by doing incremental innovation. He also states:

"It is not like for 20-30 years ago when you set up a production-line for a gearshift and knew that the next 20 years you would live on that. (…) Those things will bring out new technologies, new types of vehicles that we have never seen before. And that is why we also have to be in the front of the shoe. Then we also have to think outside of the box and do something different than we do today. (…)"

Informant 1

Informant 1 states that the company must innovative because of the rapid technological advances they face, which is one of the point Damanpour and Wischnevsky (2006) made about why companies needed to innovative to grow or even just survive.

"(…) A lot of times we work on improvements. We work on product development. That in itself is improvement, it is new functionalities that should cover new needs. (…) We use the technology we already have experience with. We sit with people that have competence in optics, we sit with people who knows electronics, software and hardware. And then there is somebody that have seen that market, who sits in their own department. NN I think his name is. I think he sits there alone actually. He is an old salesman who has been assigned to bring forth these kinds of creative ideas. (…)"

Informant 4

Informant 4 stated that they mostly focused on product development, and improvements of existing products, which is similar to what Chandy and Tellis (1998) called incremental innovation. However, they also had one guy that was typically searching for possible new configurations and combinations of existing products by combining competence between disciplines and searching for new markets. These traits are fairly similar to what Troilo et al (2014) and Chandy and Tellis (2000) defined as radical product innovations. It seemed like the focus of company 4 was incremental innovation, but that they did have some radical innovations that was based from spinoffs.

Informant 2 and 3 also stated that their companies mostly did incremental innovations, but both of the informants said that they had examples where they had brought forth radical new innovations, but that they mostly did incremental innovations. Informant 2 argued the reason was that the customers could not buy new technologies for every projects, and that the customers were relatively conservative. Informant 5 answered a bit different than the others:

> *"We are very little incremental. We lay in the middle towards radical. We have had. I must argue that for example the NN, the electrified ski binding, that is a relatively radical new idea. So we lay somewhere in the middle towards high. Totally clear at our firm. Incremental innovation, then it is continuous improvements that you get from quality systems. So I have never liked it. I see it is used, but it is something that every firm does on their own standard products. Then you always have to develop certain parts. But that is continuous improvements. Yes that is the same as incremental innovation. I find disruptive innovation much more exciting. Technology development happens so rapid now. So now it is much more technology that can be used in new products. And then you can end up with that… If you make products that knocks the feet under old product, like disruptive in its sense. That is what I think is exciting. It is a whole new… When we work with some products that can have that effect. But I like the radical innovation. "*

<div align="right">Informant 5</div>

Both informant 1 and 5 stated that they found radical or disruptive innovation very interesting or exciting, and from the answer of informant 5 he states that incremental innovation is continuous improvements. As stated in the introductory chapter, company 5 is more like a consultancy company that do product innovation projects for other high technology firms. Informant 5 stated that he believed that the reason they do mostly radical product innovation was that most firms are capable of doing development to improve existing products in their specialized field, but typically those companies have a very small path, and are specialists, but are not able to look outside of their area, so that is where they need help.

4.1.3.2. Summary

Based on the provided information it seems like companies 1-4 mostly do incremental innovation, with some exceptions in each firm, while company 5 mostly do radical innovation. Although company 5 is also a large company, it seems like they are not suffering from theory of inertia, and they are flexible. However, this seem like it is because they do not sell products, but rather develop products, and sell the concepts or product to other companies that will sell it to customers. In that way, it is somewhat contradictory to theory stating that small firms are more innovative because they are more flexible, and can accept change better (Damanpour and Wischnevsky, 2006), when company 5 is a large firm but have the traits of what the literature argue for a small firm. This could however be because company 5 is somewhat an outlier in this study by being more of a consultant, compared to the other manufacturing firms.

4.2. Organizing for innovation

One of the major investigation areas for this study was how companies organize for product innovation. I wanted to find out if, and how, companies purposely, did or did not, organize in order to promote innovative behavior. I wanted to see if they organized in one way for radical innovation, and a different way for incremental innovation. The literature suggest some elements associated with the different type of innovation the organization pursue, like Tushman and Smith (2002) suggesting an organic structure for radical innovations and mechanical structures for incremental innovations. Tushman and Smith (2002) also suggest a loose and decentralized structure, heterogeneous human resource, and strong technical competence for radical innovations, and centralized structure, efficiency culture, centralized structure, and formalized roles.

All of the informants were first asked to shortly describe how the company was organized, and then I asked them if they were organized in a special way to promote product innovation. Dependent on the answers, follow up questions were asked for more depth. After presenting the model of the different types of product innovation and what type they focused the most on, they were asked if they were organized in a certain way that separated between different types of innovation. They were also asked if they had one department or unit for radical innovations, and one for incremental innovations. Following are the answers of the informants:

"How it looks right now is that we have one production-line, pure production, and we have R&D. And we have also started a new department that is called "special products" and that is innovation etc. (…) It is an own. Like unit that does technology scanning to see what kind of technologies exists, search for eventual acquisitions if that is of interest. Or look at development in general, what BA (business area) that could have benefit from that technology. It is supposed to be the link in a way. For innovation and concept development. R&D departments are very specialized and remain very specific towards the products that we do, and does innovation and development only on those products. (…)"

<div align="right">Informant 1</div>

Informant 1 stated that their R&D department typically worked to improve their specialized products they already had, but that they recently had started a new department called "special products". The fact that this special products unit was looking more in width, and at other aspects that the R&D department previously did not do so much of, my interpretation of this department seemed to focus more towards the radical aspect of product innovation. In that sense, organization 1 seem to have sort of the same model as Tushman and Smith (2002) suggested about having one unit to focus on incremental innovation and one unit to focus on radical innovations. Next up is informant 2's answer to how the organize:

"(…) But we are organized after the matrix model. (…) it is a professional matrix structure where the projects gather resources from the product groups, and my thought then is to get all the knowledge that the product group have contributed with in the project. And when the project theme mobilizes, the product leaders sits with the resources and the knowledge so it should have a positive effect on the next project. It is not always good. With background that some resources work at many projects. (…)

<div align="right">Informant 2</div>

Informant 2 answer that they use the matrix model, but also claim it is not always good, because some people end up working in many projects at the same time. Davidovitch, Parush, and Shtub (2010) claims that a matrix structure is typically used in firms that face complex and dynamic environments demanding continuous innovations. Two of its advantages are high level of integration and better communication, and they also claim that project management

becomes much more complex because they have to be in two chains of command, this seem also to be what informant 2 refers to as somewhat problematic.

The part of the company that informant 3 works in are mainly concerned with later phases of product innovation compared to all of the other companies in this study. Typically, their unit receives a design, a concept, an idea or specification from another part of the organization, and then their innovative contribution to the product is to develop, improve or change the concept in order to meet market requirements, and be able to fit in a production line. In the unit where informant 3 work, they have an engineering department, production department, a financial manager, and a program manager. Following is the answer of informant 4:

> *"(…) We have two program areas, and we have one development department, and support departments, and production department, because we had pretty high production.. The development department is absolutely largest. (…) At our place they are called R&D and the development department is called business development. But we work very project oriented. (…)That is how we are generally organized. Very, very project oriented. So you take like everybody in the development department and place in projects. Then it is a bit like matrix organizational structure actually. (…)*

> Informant 4

Informant 4 claimed to be very project oriented, and that they have a matrix structure organization. Matrix structure is however a hybrid of functional and project oriented management (Davidovitch, Parush, Shtub, 2010). In regards to organizing for product innovation, and especially radical innovation, they claimed that it was mainly just one person that sat in a separate department, trying to look for spinoffs and other new possible market entries by combining existing technologies etc. This is fairly similar to how informant 1 claimed that they were organized also, with one part of the organization focusing on incremental innovation, and another one to focus on radical innovations. Next up is the answer of informant 5:

"We are very project oriented. Because 99% of what we do are projects, so we have traditional matrix organizational structure (…) I think the matrix organizational structure is great, while others really despise it, but I think it is great. (…) We try to develop a sharing culture, we ask for help. Culture instead of organizing own rooms etc. So the culture term is larger for us when it comes to innovative thinking. (…) We do not have a separate unit for product innovation. We organize based on discipline, so we have embedded unit, software and systems engineering, and also mechanics, and simulation. And then we also have production. We do not have to organize that way because everybody work with innovation or product development all the time."

Informant 5

Similarly to company 1 and 4, company 5 also claim to have a matrix structured organization, and informant 5 really seemed to appreciate their organizational structure. They primarily focus on projects, and informant 5 said that they organized based on different disciplines. Informant 5 also emphasized the importance they placed on the sharing culture in their company. According to Amar and Juneja (2008), encouraging knowledge-supporting culture in organization can contribute to more creative and innovative behaviors. This was something that informant 5 believed was very important, that people should talk between departments, people should ask and answer each other, and hence have a knowledge-supporting culture.

In the next section, how many people, and what sort of competence the companies utilize when developing product innovations are discussed. Informant 1 answered:

"(…) I actually like to bring in people that have not have anything to do with it. Because they have a different attitude and are not governed by the demands that often is there. (…) They do not have the barriers that stop them, they just keep on going. But we do not always have that sort of 'luxury' that we can just throw in people that do not have anything with it. Most of the time you have to bring the people that work with it on a regular basis. (…) but then you have to break the barrier when we discuss solutions and someone says "yes, but it cost to much to do etc", so you break the barrier by saying "now we forget that, cost is not relevant". (…)"

Informant 1

One important element of product innovation that Monge, Cozzens and Contractor (1992) stated was that the manager should keep the employees motivated to be able to be innovative. As informant 1 answered, he would prefer to bring somebody that had not worked on the same product previously in, because they were not bound by barriers, or to make sure that somebody would break up when somebody came with negative claims that hindered innovations. This seems likely to be motivational related, because if you come up with an idea, and are immediately met by a reaction that it is not possible because of this and that proof, then than idea is likely to stop there. This was also something that informant 1 was saying was typical for their business. That some seniors that had worked there for maybe 30-40 years was very fast to break down new ideas, because they were path-dependent on what sort of products were possible before, but because of how much technology have evolved over the years, what was considered impossible 30 years ago, might be possible now. Next up is the answer of informant 2:

> *"(…) We get resources back from the product department. Some can be experts in design, some know CAD, some are doing calculations, it can be flow assurance, it can be final element methods, it can be business analysis, marked, communication, the one or the other thing. So when we have a project, we man up for that project. (…) We set up a team, we work on a task, all right next thing, let's do an idea workshop to see if we discover something else, who do we want to join? "yes, he is skilled, he knows what he is doing, did it good there, clearly social, good contact network, all these great things" then you put them together. (…) If you do no fit in, if I can use some brutal words, if you are not innovative, if you are happy nailing wooden boxes to say it in a dorky way, and do not even change how the box looks like, then you do not fit in. If you find out that this box can be used in many different ways, "I can look at it here and there, and with a lid it can be used in another market", that is the type of resource we are looking for. (…)"*

<div align="right">Informant 2</div>

Based on the answer informant 2 gave, it was obvious that what sort of competence they brought in to do product innovations dependent on what competence was needed for different projects. He stated that they typically started with two or three senior developers that hat 20-25+ years of experience to look at a problem area, and then they typically brought in more

people into a team to do idea workshops to generate more ideas. It was important that the personnel they brought in for the teams was innovative, he provided an example that they looked for people that naturally were curious to look for alternative solutions for things, and not just settle for the current situation. However, he also stated that it did not work if they only brought in innovative people; they needed people with technical experience as well.

Informant 3 answered that the most important competence they needed in the product innovation process was process competence and quality competence, and other than that, they had to make use of all the competence tied to whatever processes that were involved. If they were working on something related to heat treatment of some metals, then they would need competence of the technology, the laws, and specifications. Following is the answer of informant 4:

> *"It is totally dependent on the project, what tasks that should be solved. Like how it is over there now it is all the categories. But the main groups are mechanics, electronics and software, and then we have a small amount of project leaders, like technical project leaders. (…)"*

Informant 4

Informant 4 also stated that the competence they brought in for product innovation was dependent on the project. He also said that the project leaders typically was brought up from the company, and typically not people that had been employed externally, because the products they produced was so complex. Company 5 said that they had different units, such as embedded, software, mechanics, simulation and systems engineering, but that the different disciplines work together in the projects. They had experts from different fields working side by side, and people with experience in different industries working together in the same projects to get diversity and a broad knowledge that could lead to crossover of competence to enhance the innovations.

4.2.1. Summary

All the investigated companies are large global companies, and hence are located geographically around the world. In that case, it was interesting to ask the informants if they collaborated with other units in other countries. All of the informants claimed that they did collaborate to some extent, but company 1, 2, and 5 claimed that they had plans to work closer with other units on product innovations globally.

From these answers, we could see that company 1 and 2 said that they typically use people with senior positions with much experience about the company and their product history when doing product innovations. Informant 1 saw it as preventative for product innovation, whereas informant 2 saw it as a necessity. Company 3 and 4 gathered different competence dependent on the projects, and company 5 typically had multidisciplinary project groups working together on all projects.

Huang, Arundel and Hollanders (2011) claimed that almost half of the innovative firms they studied did not perform R&D in-house. However, in our study, all of the companies performed the core elements of product innovation and R&D in-house. Some parts of the R&D-phase that some of the companies outsourced was some elements of a new product that was not directly related to the core product, and of course as previously stated, company 5 is a company that take upon R&D and product innovation projects for other companies. Underneath is a model summarizing the key findings relating to how the investigated companies organize for product innovation.
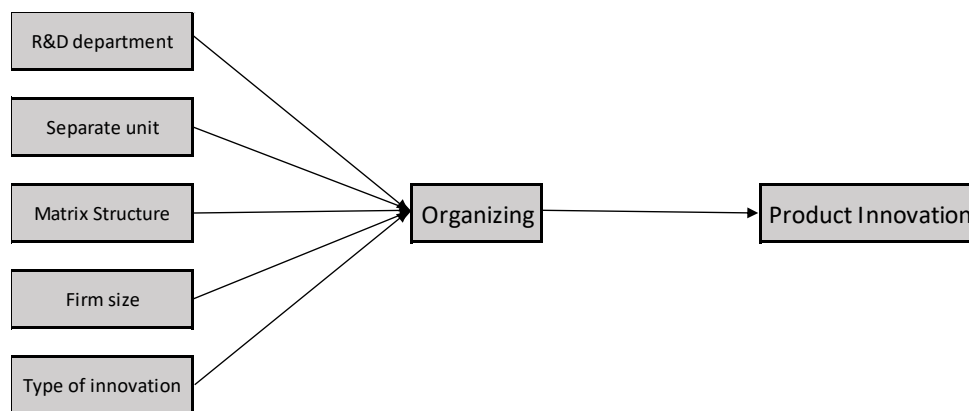

Figure 10: Variables related to organizing

4.3. Methods for product innovation

What methods large firms that produce high technological products use for product innovation was the second major part of this study. Monge, Cozzens, and Contractor (1992) claimed that product innovation is intentional, and that managers should focus on motivating employees to promote innovative behavior. In regards to what methods companies use, the focus is on what managers intentionally do to promote innovation. What actions are put in motion that can make innovation more likely in that company? Example of actions that can be taken that can have an effect on innovation are how they are organized, facilitating resources, time, multidisciplinary teams etc. There are many different theoretical processes and methods that managers can follow/ use for product innovation. How the investigated companies promote innovative behavior are described in this section.

Some of the questions asked was first to give a general outline about the process of how their firm did product innovation. Next I specifically asked the informants how their firm comes up with new ideas, how they specify the area they want to do product innovation, how they involve the customer/ end user in the innovation process and how they organized further to make a product out of an idea. I also asked all the informants if they used any specific tools, and what their experiences with those were. Lastly, based on Chandy and Tellis (1998) statement that firm's willingness to cannibalize own investments was a better indicator of their radical innovation capabilities than firm size as predictor. The informants were asked to evaluate their ability to kill own investments if they happened to not be good. Killing investments was stated as the ability to walk away from own investments if they did not provide the desired outcome, or generally just were not good.

Informant 1 presented a model their company used for product innovation. It was a process of how they were supposed to do product innovation, they did not have to completely follow it, but it gives direction on what to do next throughout the process. Informant 1 stated that they typically go up and down, and in and out of the process model, and mostly use it when they get stuck to get inspiration/ direction. The company created this model themselves, based on other models and experiences. Their process started by defining roles, where the designer will have the last word so he can change direction if he felt like they are going the wrong direction.

Next they define the problem, and find out exactly what the customer wants, and after that is settled, they start to generate ideas. Typically, ideas have some demands depending on the problem area, for example, the temperature it must withstand etc. When asked how they did idea generation, informant 1 replied:

> *"What we do then is that we have a problem etc. Then we use these different methods. We use for example '5 why's'. I try to kick this very hard in, because that is something that can be used very much for incremental innovations also. (…) If we talk about disruptive innovation, that is a bit different and try to look at 'Eureka', '6-thinking hats', that is a classic, used that a lot. (…) Yes 6 hats, I think we have used it here twice. First time it was total chaos… because then. I think the culture was not 'up to date'. People did not understand why they should be doing all these hats, and what the purpose behind it was. (…) so that was a bit heavy. But the second time we did it there was a bit more progress and people were a bit more open. (…)*

<div align="right">Informant 1</div>

Before company 1 start their product innovation workshops, they find out how all participants prefer to generate ideas and make sure everyone knows the problem statement. When they do different kinds of ide generating methods, they never do more than 15 minutes to avoid getting fatigued. In their document, they also have all sorts of technical and innovative inspirations, such as a website they can use that shows all kinds of mechanical movement solutions. A few days after the idea generation they typically have a session where they try to break down the ideas, where they are allow to try to kill the idea. This was to prevent the idea to be developed too fast, be sent to the production units, and then suddenly there are many problems. In regards to how they involved customers or end users, informant said that it was mainly the designer of the project that was in contact with the end users or the sales team. The process company 1 uses is very similar to the design thinking process that starts by empathizing with the users, then define problems, before they start the ideation. Company 1 had many different methods for idea generation, and informant 1 seem to have a grip on which model was good dependent on what type of innovation they were creating. He was suggesting '5 why's' for incremental innovations and 'Eureka' or '6 hats' for disruptive innovations.

(…) You can say that innovation depends completely on the culture. If you do
not have a culture to do innovation, then you will not get much done. (…)"

<div align="right">Informant 1</div>

Informant 1 also stated the importance of the culture of the firm in order to be innovative, which is also what Amar and Juneja (2008) claimed. Next up is informant 2's statement on how they come up with new ideas:

"(…) But if we are talking about if we have own gatherings where we are
sitting and 'delicately thinking', to say it in that way. We do not really have
that. The ideas come up based on the knowledge we have about a need. It is
seldom an invention comes up if you did not know it was useful. (…)"

<div align="right">Informant 2</div>

When asked how company 2 generate new ideas, informant 2 emphasized the importance of knowing the user need, and also claimed their experience was an important factor of innovation, where he assumed they had an average experience of between 20 and 25 years.. When informant 2 was asked what types of methods they used, he replied:

" Workshops, and idealabs also. And. Yes you can just Google, then most of
them come up. (…) We use those normal methods so we come into creative
mode (…)"

<div align="right">Informant 2</div>

Informant 2 was also specifically asked what types of methods they used, and he claimed that I could probably mention any type of idea generation method, and they would have tested it. It seemed like company 2 had a fairly similar process model as company 1, as knowing the customer need, defining the problem and ideation was important phases of their process. Company 2 did not have any formal documents or guidelines on how they should proceed the early phases of product innovation process as company 1 had. However, both companies had many guidelines and processes on how to screen products/ concepts.

As previously stated, informant 3 worked in a unit that very rarely worked on the earliest phases of product innovation, and hence they did not have methods for idea generation. Company 3 worked more on developing, improving, and testing concepts that were created in another unit. However, when I asked how they worked on product innovation he replied:

"Simulations. We have, we drive everything virtually all the way, from we receive the design from the customer or from NN, then we take that model and split it up to see how it can be done, split it into different operation, typically 50-60, it can also be more. Then those operations are based on experience. Typically CAD-models that describe every step upwards."

Informant 3

The innovation process of informant 3 is similar to what was described as incremental innovations, as they mostly do improvements on already created concepts. Company 3's answers were pretty different from the two other companies that were previously presented, mostly due to the fact that they worked at a later phase. Informant 4's answer to how they worked on product innovation and what methods they used, he replied:

"We do not have own tools for innovation processes or something. We have not defined innovation as a process as far as I know at least. (…) In relation to development we have a development process that we follow that we call the V. We use 'Magic …' it is a tool, it is a modulating tool where you modulate up a system that breaks down the electronics or if it is mechanics or software, in a way that specify… no that might not be innovation, it is a part of.. the process."

Informant 4

Informant 4 was uncertain in regards to if they had any process or tools that they used to promote innovative behavior, however, as stated earlier, they did have one person that was working on spinoffs, and more radical types of innovations. Company 4 did follow the systems engineering Vee model, which does outline a product innovation process as presented in the literature by Forsberg and Mooz (2005). Informant 4 did comment something interesting:

"We had a guy from NN (innovation firm) inside the firm. And he, the little I do remember, was that there was some presentations that he had, about some methodology, and at the time, we were doing technology, what was innovation? He was allowed to mess around and do his thing for a bit (…) I was an engineer myself when I heard it, and for me nothing ever happened, I never saw anyone or anything he had an effect on either. Then he was places as a development manager or something, and he did not like that, so he did leave the business. In that way I would say he did not do anything."

Informant 4

From the example provided, company 4 had hired an experienced innovation person, however, informant 4 did not really believe that he was able to accomplish anything. The reason why the methods he tried to introduce did not work are unknown, but it is a possibility that it was cultural reasons. Maybe the people in company 4 was not motivated to try his methods, and hence not motivated for innovation in that way. When asking company 5 how they come up with new ideas, he replied:

" (…) We use the Vee-model, and stakeholder requirements, validation principles that lays in the most modern tools, those have already been implemented and started using with good results, that is super exciting. (…) that means that we do not create reports, but rather A3's, visualizations, giga maps, road maps (…)"

Informant 5

Informant 5 claim that company 5 also follow the systems engineering Vee-model. Stakeholder requirements and validation are important aspects of the Vee-model Forsberg and Mooz (2005). Informant 5 says they are not writing reporting documents, but rather visualize this in other ways. This was also something that informant 4 stated, however, informant 4 said that they were visualizing their reports through SYSML and UML where they describe what is being made in squares, triangles and arrows with words. When asking informant 5 what tools they use for product innovation, he answered:

"(…) Our culture is one part (…) the other part is that we base around the system Vee system engineering thinking. That is our method tools. (…) We are strict wit hour methods. You should not think that when we are this innovative. But we are. (…) But the methodology help you to think correct. And that is something we think is good. We have both good methodology: 'System Vee', 'Rapid Learning', Knowledge Based Development', those are the principles we lay as foundation. Rapid learning cycles are important. Testing. (…) In one project, we create hundreds of what is called A3's, which is the way we document our ideas. (…) on one A3 page you document an idea, and tell a bit about the perspective. (…)

Informant 5

In addition to the system engineering Vee-model, informant 5 said that they focused on rapid learning cycles as a way of testing concepts. He also explained that they often used very simple materials to create fast prototypes, and that in their workspace had a large pile of Lego that they could use. He also claimed that this was something that they had successfully used in order to demonstrate a concept to a customer that got the customer very excited, as it was just what they were looking for. This is a concept described in the Design Thinking process, namely 'rapid prototyping', where you try to create simple prototype in order to see if concepts or ideas are feasible (Luchs, Swan, and Griffin, 2015). Some of the advantages of rapid prototyping is that it is very cheap, and you can let the user actually see, touch, and interact, and play with the product in a very early phase to get feedback (Lande, and Leifer, 2009). Informant 5 also stated that they create A3's to demonstrate their ideas, and he claimed that in the screening process, where they take away and end up selecting concept, that the customer is actively involved. They are included and see how company 5 do their selection, and that they meet the customer's requirements etc.

When it comes to the firms willingness to cannibalize own investments as Chandy and Tellis (1998) called it, informant 1, 2 and 5 said that they use stage-gate in the knowledge based development process. Company 1 stated that had very high requirements in order for a new concept to make it through the stage gates, and that the reason that they had so high requirements for the concepts, was because they were afraid of actually having to cannibalize their investments at a later stage. For company 4 it was very different compared to the others, considering that governments were their biggest customers because they operate in the defense sector. Company 4 generally did development and innovation funded by the government, so they were not as concerned about how they spent their money, but rather tried to produce products with the best possible specs, so they kept adding value, and from informant 4's experience in the private sector, this was a way different approach in terms of efficiency pressure. Because of the 'snowball-effect', if the government had already paid 500 million kroner in R&D expenses for a product, they would not likely pull out of it at a later stage.

Company 1 and 2 also said that that all employees were aware that if somebody gets an idea outside of the product innovation process, they had routines were anybody could report their ideas. Company 1 said they really encourage employers to think about new ideas and if they think they have something good they should write what informant 1 called an Innovation Notification Form.

4.3.1. Summary

All of the companies were following some sort of a product innovation process. Company 1 had a model that they had created themselves, with many similarities to the Design Thinking process. Company 2, 4 and 5 was using the System Engineering Vee-model as their process approach for product innovation. Informant 4 stated that they did not have a product innovation process model that they were following at their unit, because they did not generate the ideas or concepts at their department.

In regards to how the companies came up with new ideas, company 1 and 2 claimed that they were using several different methods for idea generation, such as 'brainstorming', '6 hats' and '5 why's'. Company 3 was heavily focused on simulations and visual illustration of the concepts. Informant 4 was not sure if they had special method they used for product innovations, but knew that one person in the firm was working alone specifically to work on spinoffs and more radical-like products. Company 5 was mainly using A3's to present their ideas, but did not use any special methods to generate ideas. Informant 1 and 5 emphasized the importance the culture have on product innovation, and informant 1 and 2 mentioned the importance of having the right people when using the methods.

When it came to the firms' willingness to cannibalize, the informants mostly talked about what processes they implement in order to prevent having to cannibalize their investments, by screening out bad ideas early. However, it did seem like all of them were very aware how fast a 'new' product could turn old, and the effects a disruptive or radical innovation can have on their business. On the next page is a model summarizing the key findings relating to what methods the firm analyzed are using for product innovation.
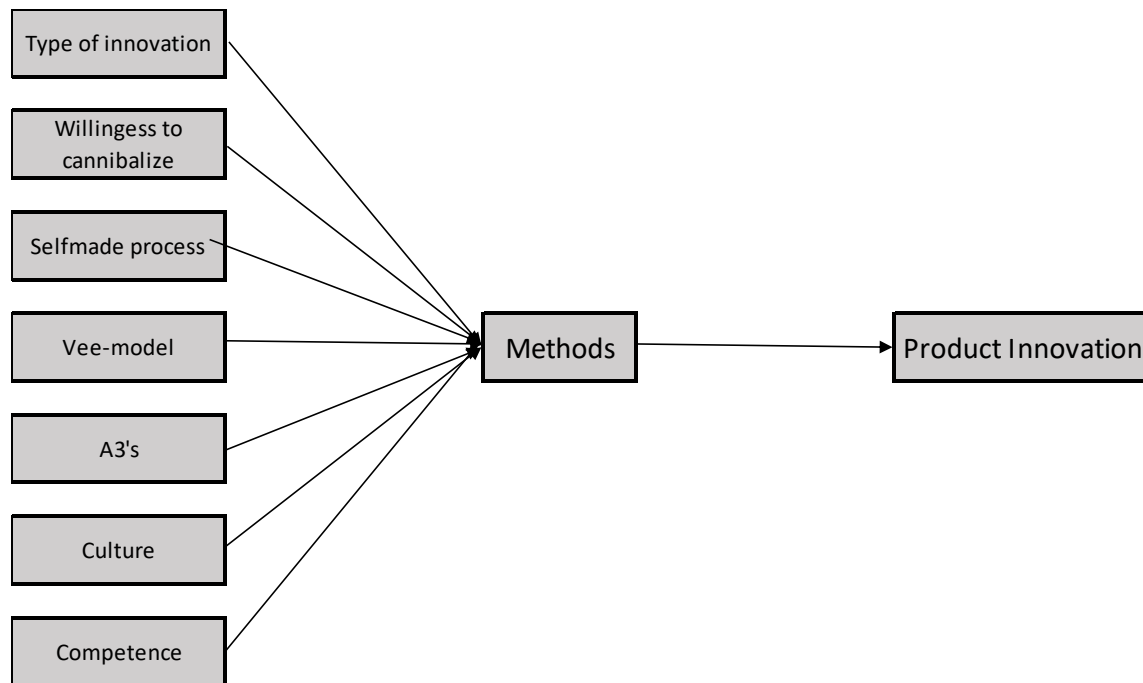
Figure 11: Variables relating to methods

4.4. Summary of the analysis

Some of the main findings from the analysis are summarized through the operationalized research questions. The answers of the operationalized questions are provided in the section following the operationalized research questions below:

1. *How do large firms that produce high technological products organize for product innovation?*
    a. *Why do they do it that way?*
    b. *Do they have independent departments for innovation? One for incremental innovation and one for radical innovation?*
    c. *Does this differ dependent on the size of the business?*
2. *What kind of product innovation methods, tools or frameworks etc. does high technology firms use to come up with new ideas/ products?*
    a. *Do they have planned workshops, do they appear randomly or do they have special departments for incremental and radical product innovation?*
    b. *What competence is included in the product development phase?*

1.) All the companies except company 5 had a R&D department. Company 5 did not have a separate R&D department, they had separated into disciplines, but all of the disciplines worked together. Company 2, 4 and 5 stated that they were following a matrix organizational structure, where company 4 and 5 said they were very project oriented. Company 1 have a R&D department, and also a new unit that focused on other aspects of innovation than the R&D department such as not being so specialized in one area. Company 4 also claimed that they had a separate department comprising of one person that worked on spinoffs and more radical-like products than their R&D department.

1. a) Informant 1 claimed that their new department was supposed to take on new tasks that the R&D department did not look so much on now, and work as a link between R&D centers in the organization. Informant 2 stated that one of the reasons they were using the matrix organizational structure was because then they could utilize the same resources in several projects. However, he also pointed out that this was sometimes a weakness, because when

some people work in many projects, they do not have the time to fully think about one project before they have to move on to the next. Informant 5 claimed they mostly produced radical innovations, and emphasized that they focused more on having an innovative culture in the organization than how they organized their firm.

1. b) Company 1 and 4 had other units than their normal R&D departments that seemingly worked on innovations with a more width in their focus, and with traits that seemed like they were focusing more on radical innovation. In that way, based on the answers provided by company 1 and 4, they did separate and had one department for radical innovations, and one for incremental innovations. However, the other companies in the study did not seem to organize their business to focus more on radical or incremental innovations.

1. c) Whether or not it is different for large or small firms how they organize for radical or incremental innovations is difficult to say based on the answers gathered in this study. Many of the informants did state that they believed that smaller firms were more likely to be able to do radical innovations because they were more agile and flexible, and that larger firms tended to become too bureaucratic which hindered their innovative capabilities. Some of the informants also stated that smaller firms lacked some potential to be radical innovative because they did not have the same financial backing that they considered necessary.

2.) All of the companies have some sort of methods or processes that they follow for product innovation. Company 1 had a model that they had created themselves, which have many of the same elements as the Design Thinking process. Company 2 were not following any specific model, but typically gathered 2-3 when discussing new areas/ problems to investigate, and then created teams for further investigation into the problem areas. Informant 2 did state that they had tried many different methods for 'ideation'. Company 3 mainly focused on simulations and visualizing everything they did. Company 4 and 5 were following the systems engineering Vee-model, and company 5 stated that they used A3's to generate ideas, and visualize their concepts. Company 1, 2, and 5 also stated the importance of having the right people and the right culture when doing product innovation. It was important that the people were motivated, and that they were creative and skilled persons.

2. a) Company 1 focused a lot on having planned sessions with workshops in order to generate ideas, that was also one of the reasons they had created their innovation process document, so it would be easier to facilitate workshops. Informant 5 said that when they were working on new ideas, they were mainly using A3 papers, and collaborating with each other to generate ideas. Company 2 carefully selected people they would bring into idea workshops after they had selected problem area to focus on. Informant 4 did not think that they had any sessions like that, as they mainly worked on developing and improving products, he did however reflect on an experience he had where they previously had tried some sort of innovation process that he believed was a failure.

2. b) Informant 2, 4 and 5 answered that the competence they used in product innovation heavily dependent on what sort of competence was needed for that project. Informant 2 did state the importance of having the experienced people when doing product innovations, as he claimed it was not good if a person was either just technical or just creative, but that they needed both. Informant 1 said that he often preferred to bring people in that had not worked on the same product previously, because they did not have the same barriers, and hence were more innovative because they could think more freely. Informant 1 also talked about that they had typically used people in senior positions that had been in the company for 30+ years, that could typically kill new ideas based on things that was not possible in the past.

On the next page is an illustration of the summarized variables that affect how the investigated firms organize for product innovation, and also the methods they used for product innovation.
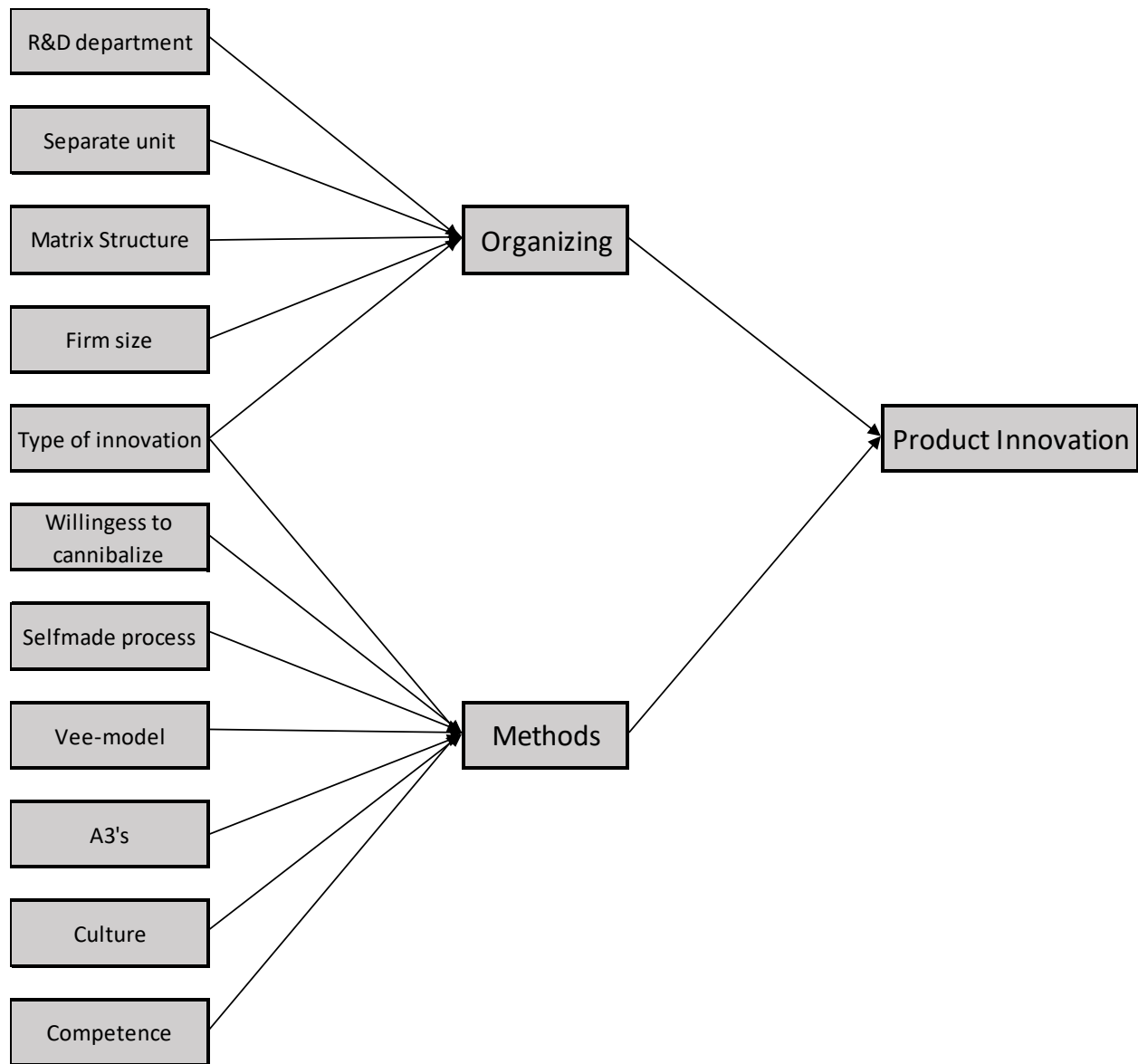
Figure 12: Summary of the variables

5. Discussion

In this chapter, the findings shown in the analysis chapter are reviewed, and the research question is discussed and reviewed against the results and the theory presented in chapter two. Following in the next section, the conclusion of this study is presented, and after that, the implications for this study are presented. In section 5.5. I have described some of my reflections of this study, and finally in the last section I present my suggestion for further research.

The goal of this thesis was to learn about how firms can organize for innovation, and what methods and processes that can be used, and specifically, be able to answer the following research question:

> *"How do large firms that produce high technological products organize for product innovation, and what methods do they use to promote innovative behavior?"*

In the next section, the findings on how firms are organized for product innovation are discussed and compared to the literature and the research question. Following this, a section where the findings from what methods or processes the firms use for product innovation are discussed and compared to the literature and the research question.

5.1. Discussion - organizing for product innovation

In the following sections, I will present the key findings relating to how the investigated firms have organized for product innovation. The categories relating to or affecting how the firms organized for product innovation are firm size, type of innovation, R&D department, and organizational structure presented in the model on the next page.
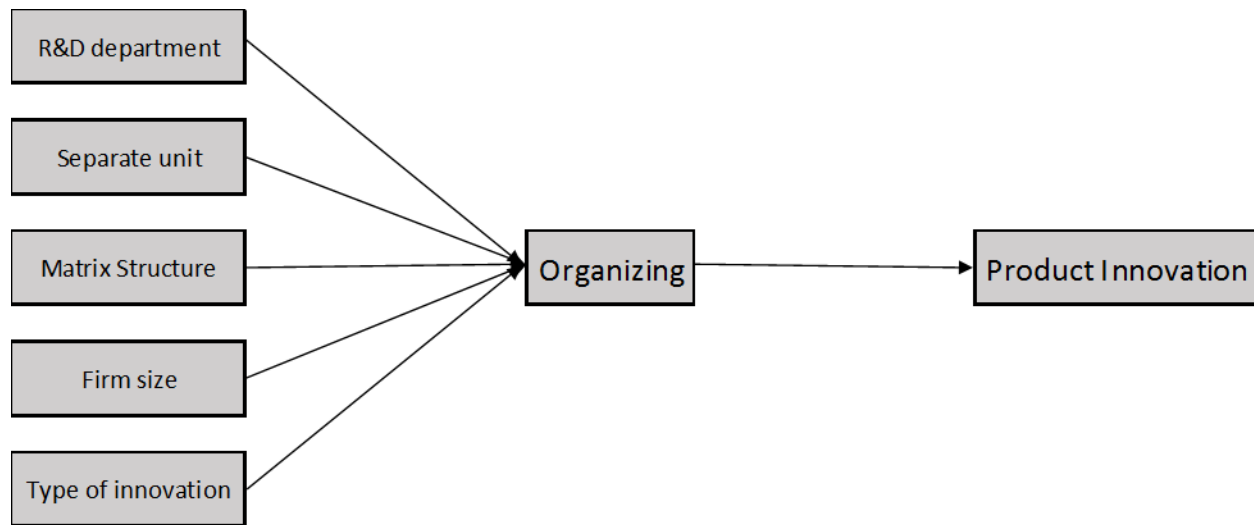
Figure 13: Variables relating to organizing

5.1.1. Firm size

In the literature there were inconsistency when it came to researchers view on the relation firm size have on product innovation (Ettlie, Bridges, and O'Keefe, 1984; Camisón-Zornoza et al, 2004; Damanpour and Wischnevsky, 2006). All of the firms interviewed were large, so comparing how well the different company do product innovation in order to try to prove that firm size have a positive or negative effect on innovation compared to small firms would not be a good method. However, all of the informants were asked to present their view on how they believed firm size affect product innovation. These answers were subjective and could be purely based on personal opinions. The main findings were generally that most of the informant believed that large firms had the advantage in terms of innovative potential because of their financial backing, but also that smaller firms had the advantage over larger firms because they were more flexible and could turn around faster. These points are very similar to how Damenpour and Wischnevsky (1998) distinguished small and large firms. Because the opinion of the informants also are contrary in terms of whether size can be a predictor of innovativeness, we can say as Camisón-Zornoza et al (2004) stated, that there is inconsistent evidence also in this case.

5.1.2. Type of innovation

Based on the literature presented in the literature review, you can distinguished between four types of product innovations (Chandy and Tellis, 1998). I wanted to study what types of product innovations the companies produced, and if they organized in a certain way dependent on the type of product innovations they produced. Informant 1 and 5 was talking about an additional type of innovation that they argued was even further out than radical innovations, namely disruptive innovations. This is not an important finding or anything, as the separation of the four types of innovation was just a way to allow the companies to simply distinguish between types of innovations, and Christensen (2013) also used the same term presented in the literature review.

Company 1, 2, 3, and 4 claimed that they primarily focused on incremental innovations, in the sense of improving existing products by adding value or features etc. All of the companies did have examples of products they had produced that were radical, but they mainly focused on incremental innovations. Informant 5, however, claimed the opposite, they mainly did radical innovations, but had examples of incremental innovations also. Company 5 is different from the other companies, in the way that they do not produce their own products, but rather produce products for other companies, in a consultancy like way. Tushman and Smith (2002) states that typical traits of firms that produce incremental innovations are an efficiency culture, formalized roles, centralized structures, engineering work processes, and coordinating mechanisms. An efficiency culture was recognized as an important factor in all of the firms except company 4, because company 4 was not operating in the private market and did not have to deliver as efficient as the private market demands. One contradictory finding compared to the literature was that company 5 claimed to be flexible and had traits of a small firm, and did not seem to be suffering of the theory of inertia (Chandy and Tellis, 2000), even though they were a large firm producing radical innovations.

5.1.3. R&D department

Blindenbach-Driessen and Ende (2014) argued that innovation management discipline of traditional paradigm claim that research and development should be organized as a separate department. All of the firms investigated in this study had R&D departments in-house to produce the core parts of product innovations, but some of the firms did outsource smaller elements in some projects. Company 5 was a company that was taking projects that other companies outsourced. Compared to the findings that Huang, Arundel, and Hollanders (2011) presented that almost half of the innovative firms in the study outsourced the R&D activities, our findings are very different. Although some of the companies outsourced some elements of the R&D process, all of the companies did the major parts of the R&D activities, and hence this study presents contrary findings.

5.1.4. Organizational structure

Dougherty and Hardy (1996) argued that many firms fail to create successful new products because they are not organized to facilitate innovation. How companies organize for product innovation was the first major part of the research question. Company 1 and 4 claimed to some extent to have one unit of the organization to focus on incremental innovation, and another unit to focus more on radical-like innovations. This is similar to one model Tushman and Smith (2002) suggested as organizational structure for product innovation.

Company 2, 4 and 5 stated that they were following a matrix organizational structure, where company 4 and 5 said they were very project oriented. Informant 2 stated that one of the reasons they were using the matrix organizational structure was because they could utilize the same resources in several projects. However, he also pointed out that this was sometimes a weakness, because when some people work in many projects, they do not have the time to fully think about one project before they have to move on to the next. The weakness pointed out by informant 2 is also a disadvantage found in the literature, because project management become much more complex when they have to be in two chains of command (Davidovitch, Parush, and Shtub, 2010).

Informant 5 claimed they mostly produced radical innovations, and emphasized that they focused more on having an innovative culture in the organization than how they organized their

firm. According to Amar and Juneja (2008), encouraging knowledge-supporting culture in organization can contribute to more creative and innovative behaviors.

5.2. Discussion - methods for product innovation

In the following sections, I will present the key findings relating to what methods and processes firms utilize for product innovation. The categories relating to or affecting what methods the companies use are: willingness to cannibalize own investments, competence included in the innovation process, culture, and finally what product innovation methods the companies use. These are illustrated in the model below:
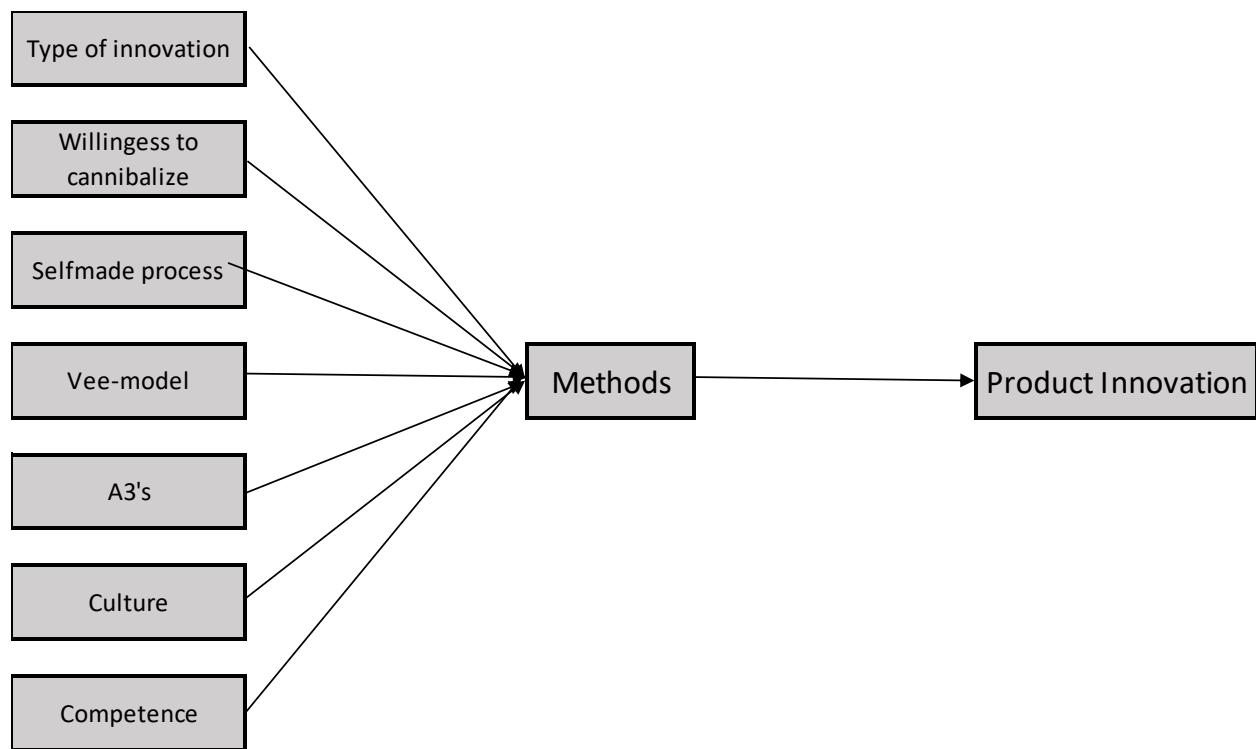
Figure 14: Variables related to methods

5.2.1. Willingness to cannibalize own investments

Chandy and Tellis (1998) argued that the firm's willingness to cannibalize own investments was a better indicator of their ability to generate radical product innovations than firm size as predictor. When the informants were asked about this, most of the informants studied answered that they had long and descriptive processes to prevent having to cannibalize their own investments. They had processes that new concepts had to pass through, and in that way they claimed to be able to screen out the ideas that had the potential of being bad investments

at an early stage rather than later when they become very expensive. These findings does not prove either that willingness to cannibalize is a better- nor does it prove that it is a worse indicator of firm's ability to cannibalize own investments.

5.2.2. Competence

All the informants in this study were asked what type of competence they use when doing product innovations. Seidel and Fixon (2013) argued that a team with diverse backgrounds will increase the team collaboration. Strong technical competence is also one of the variables Tushman and Smith (2002) mention as typical for firms that generate radical innovations. Company 1 and 2 claimed that they typically use experienced people with senior positions in their innovative processes, but informant 1 stated it as preventative for product innovation where informant 2 saw it as a necessity. Informant 1 said he preferred using people that had not previously been so involved in the area they were trying to develop an innovation in, because then they were not hindered by old assumed barriers. This relates to Monge, Cozzens, and Contractor's (1992) argument that innovation is intentional and requires motivated employees, because it is likely demotivating for people if they propose an idea, and immediately are met with an answer stating it is not possible. Informant 4 and 5 said that the competence they bring into projects differs dependent on what competence is needed for different projects.

5.2.3. Culture

As mentioned, encouraging knowledge-supporting culture can contribute to more creative and innovative behaviors (Amar and Juneja, 2008). Company 1 provided an example of one time when he attempted to use an ideation method in a workshop that ended up in total chaos because they did not have the culture to facilitate it. People were unwilling to try it the first time. Informant 1 further claimed that if you do not have culture to do innovation, you will not get much done. Informant 5 also claimed that their culture was more important than how they were organized. Company 1 and 2 also mentioned the importance of having the right people in the product innovation process, people that were both creative and skilled. These are also traits relating to what Brown (2008) suggested as good traits for a Design Thinker.

5.2.4. Product innovation methods

Monge, Cozzens, and Contractor (1992) claimed that product innovation is intentional, and that managers should focus on motivating employees to promote innovative behavior. In regards to what methods companies use, the focus was on what managers intentionally do to promote innovation in their firm. All of the companies in the study were following some sort of product innovation process. Company 1 had a model that they had created themselves, with many similarities to the Design Thinking process outlined by Plattner, Meinel, and Leifer (2006). Company 2, 4 and 5 was using the System Engineering Vee-model as their process approach for product innovation similar to the one presented by Forsberg and Mooz (2005) in the literature review. Informant 3 stated that they did not have a product innovation process model that they were following at their unit, because they did not generate the ideas or concepts at their department, but rather developed and modified concepts and ideas.

In regards to how the companies came up with new ideas, company 1 and 2 claimed that they were using several different methods for idea generation, such as 'brainstorming', '6 hats' and '5 why's'. Company 3 focused mainly on simulations and visual illustration of the concepts. Informant 4 was not sure if they had special method they used for product innovations, but knew that one person in the firm was working alone specifically to work on spinoffs and more radical-like products. Company 5 was mainly using A3's to present their ideas, but did not use any special methods to generate ideas. Company 5 were using 'rapid learning cycles' which was very similar to the 'rapid prototyping' phase of the Design Thinking process where simple prototypes are created to make the ideas feasible so users can interact with them (Luchs, Swan, and Griffin, 2015).

5.3. Conclusion

In this study, I have investigated how five large companies that produce high technological products organize for product innovation and what methods they use to promote innovative behavior.

From the analysis, it is apparent that there are both similarities, and differences in terms of how the studied companies organize for product innovation. All of the companies in this study except from company 5 had R&D department, which the literature also suggested that they should do. All of the studied companies performed the core parts of the R&D processes in-house, which is contrary to some findings in the literature stating over half of the investigated companies outsourced the R&D activities. Company 1 and 4 had in addition to their R&D departments a separate unit that focused on more radical type of innovations, whereas the other companies did not.

In terms of firm size's relation to the firms innovative capabilities, the informants in this study generally believed that large firms have the advantage in terms of financial backing, but smaller firms have the advantage of being flexible and able to turn around fast. They also believed that large firms could suffer because they become too bureaucratic and hence loose some of their innovative capabilities, which was what the theory presented as well. In relation to the effect found about firms' willingness to cannibalize own investments had on innovation, it seemed evident that the companies focused heavily on not having to cannibalize their investments by having extensive screening processes.

In regards to what type of innovations the studied companies were producing, it was evident that four of the companies primarily produced incremental innovations, and the last one stated they mostly produced radical innovations. One contradictory finding was that organization 5 had some traits that were seemingly similar to traits presented in the literature typical for small firms even though they were large.

Three of the companies investigated were following a matrix organizational structure, where one of the companies stated that it was sometimes a weakness because some people had to

work in several projects, which limited their commitment in each. Company 5 stated that their culture was more important than how they organized for product innovation.

There were also similarities and differences found between the companies in terms of what methods and processes they were following for product innovation. Company 1 had a self-made process they were following that was fairly similar to the Design Thinking process, and three of the other companies were utilizing the Systems Engineering Vee-model for product innovation. To generate new ideas, company 1 and 2 were using methods like 'brainstorming', '6 hats', and '5 why's', while company 3 focused mainly on simulations. Company 5 primarily produced A3's where they wrote down and drew their ideas and concepts on an A3 paper. In order to successfully utilize product innovation processes and methods, informant 1, 2, and 5 emphasized the importance of having innovation culture and people that were both creative and skilled.

5.4. Implications

In this section, I will provide both some theoretical and practical implications based on this study. In terms of theoretical implications, this study supports to some extent the theories suggested by Damenpour and Wischnevsky (1998) in terms of larger firm having the advantage of financial backing and smaller firms having the advantage in terms of flexibility and ability to turn around. The results looking at whether large or small firms were regarded as better suited for radical innovations supported Camisón-Zornoza et al (2004) statement that this theory is inconsistent. Contradictory to the theory presented by Chandy and Tellis (2000) in terms of the benefits large and small firms have, it seemed like company 5 possessed traits of both a small firm in terms of being flexible, and a large firm in form strong financial backing and strong technical competence. This evidence is not a strong finding considering it was only one of the studied companies that illustrated this trait. This study also supported the theory of having a separate unit for R&D departments.

This study also supports the claims made by Amar and Juneja (2008) about encouraging knowledge-supporting cultures, as three of the investigated companies emphasized the significance of having the right people and an innovation culture to contribute to more creative and innovative behaviors.

Some practical implications from this study is that managers should be aware that innovation is intentional, and that employees should be motivated to promote innovative behaviors. To motivate the employees, it is important that the manager attempt to create an innovation culture. As informant 1 stated, they attempted to use an innovation method that went ended up totally chaotic the first time, but worked better the next time, so an implication would be not giving up too easily, but train people to use the methods. Another implication would be to follow an innovation process model or create one that fits the specific organization, so the firm will have guidance on how to proceed if they are stuck, and to make sure that innovations are based on certain needs in the market. It is also important that companies organize according to the types of innovations they want to produce.

5.5. Reflections

Because the aim of this study was to investigate how large firms that produce high technological products organize for- and what methods they use to promote innovative behavior, a very broad research aim is taken. If a more narrow focus were chosen with more specific focus, more depth could have been added to the study. Additionally, because this study investigated five different companies, and this study is highly limited by the short time span of a master's thesis, additional depth, in tradeoff with width, could have been gained if fewer cases were used in the study.

This study have investigated five different informants representing five different companies. The responses of the informants were based on personal experiences, their opinions, and respectively their perception of how they organize and what methods they use for product innovations. One weakness of this study in terms of validity and depth was that only one person from each company was interviewed, due to the short timeframe of the master's thesis. To compare some of the discussions held in this thesis regarding firm size, I could also have investigated some small firms in addition to the larger firms to be able to compare between the companies and the literature.

5.5. Further research

The focus of this study was to investigate how large firms that produce high technological products organize and what methods they use for product innovation. From this study, general knowledge about how companies organize and what methods they use have been established that other researchers could build upon. For further research, I suggest to attempt to go more into depth in the sense of analyzing different organizational structures and methods, and comparing them. Another suggestion for further research would be to also study small firms, and then possibly be able to find out if firm size have a positive or negative on the firms' ability to produce radical innovations.

For further research, I also suggest that researcher try to attend workshops and ideation sessions of different companies, as a triangulation method, as this would add depth and knowledge to the study. Another way to gain more knowledge, and possibly be able to distinguish what product innovation methods and organizational structures that promote innovative behaviors in the best way could be to have a large-scale test where companies were using different methods and organizational structures over longer periods of time to be able to compare the results.

From the literature review, it is evident that there are lacing and inconsistent literature surrounding how firms should organize, what methods they should use, what effect firm size have on their effectiveness etc. Based on this, additional research in this field is definitely needed.

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Appendices

Draft for interview guide

- - = Questions
- • = Explanation

Personals and general about the company

- What is your name?
- What is your position in your company?
- How long have you work in this company?
- Do you have experience from working with development in other companies? Which ones?
- How many employers is in your company?
- Where is the company geographically located?

General about the theme

- How would you define product innovation?
- • I have defined innovation as an idea, practice or object that is perceived as new by an individual or other adaption units (Rogers, 2003). It is regarded new if it has been on the market for five years or less and has expansions and significantly improvements (Cooper, 2001). The focus is on product innovation. A new product can be new for the company if it has never made it before, but other companies have, or new to the market if the product is first of its kind.
- What type of products do you produce, and in which industry do you operate in?
  - o Business to business? From orders?
  - o Direct to the consumers?

Theme 1

- Could you shortly explain how your company is organized?
- Is the company organized in a special way to promote product innovation?
  - o How? Why/ why not?
  - o Does your company have a separate/independent department for product innovation?
- • You can separate between four types of innovations – to what degree the technology is new (expansion/improvement vs totally new) and to what degree the new product gives better customer satisfaction than existing products (pr. Dollar) (see model underneath).

TYPES OF PRODUCT INNOVATIONS

		Customer Need Fulfillment Per Dollar	
		Low	High
Newness of Technology	Low	Incremental innovation	Market breakthrough
	High	Technological breakthrough	Radical innovation

- Does your company focus on different kind of innovations? (improving existing / totally new products – new technology, new market – different zones for focus?
    - Is the company organized in a way to separate between different kind of innovations?
        - One department for totally new products?
        - One department for improving existing products?
    - Could you give examples of a product your company has developed that was totally new, and one that has been an improvement of an existing product?
        - Would you say you focus more on improving products or creating something totally new?
- Do you think that the size of the firm affects the way they do product innovation and their ability to create new products?
    - Some researcher argue that large firms tend to be too bureaucratic, are less willing to take risks and react slower which makes them less likely to produce radical innovations. Other researchers claim that larger firms have the advantage over smaller firms because they have economies of scale and advantages in terms of development which make them fit to create radical innovation
- What do you think about this?

Theme 2

- Could you tell me how you do product innovation?
    - How do you come up with new products?
        - Random, suddenly ideas pop up?
    - How are these ideas taken up and put in action?
    - Why do you not use methods/tools to promote innovative behavior?
        - Bad experience with these? Little experience with using tools?
        - Use methods/ tools for product innovation?
    - If so, which?
        - How are they organized/ put in action?
        - What does the employers think of these methods/ tools?
        - How do you feel these methods work?
        - Who participate in these methods?
    - If you come up with a new product innovation, how do you typically organize to bring the idea forth?
    - How would you evaluate your firms ability to cannibalize own investments? (if you find the product was have the demand you first thought, or another product is better etc, but you have already spent money on this investment)
    - How many people are part of the development work?
        - What kind of competence do you gather in the process?
        - To what degree are customers and suppliers involved?
    - Do you work with product innovation to meet future needs, or do you focus more on meeting the needs that are in the market today?

Utkast til intervjuguide

- = Spørsmål
- = Forklaring

Personalia og generelt om bedrift

- Hva heter du?
- Hvilken stilling har du?
- Hvor lenge har du jobba med utvikling?
- Har du erfaring fra å jobbe med utvikling i andre bedrifter? Hvilke?
- Hvor mange ansatte er det i bedriften?
- Hvor er bedriften geografisk plassert?

Generelt om tema

- Hvordan vil du definere «produkt innovasjon»?
- Jeg har definert innovasjon som en ide, praksis eller objekt som blir oppfattet som nytt av et individ eller andre adopsjonsenheter (Rogers 2003). Nytt dersom det har vært på markedet i fem år eller mindre og har utvidelser og signifikante forbedringer (Cooper 2001). Fokuset er på produkt innovasjon. Nytt produkt kan være nytt for bedriften hvis det aldri har laget det men andre bedrifter har, eller nytt på markedet hvis produktet er første av sin type på markedet.

- Hvilke typer produkter produserer dere og i hvilken bransje opererer dere?
    - o Business to business? På bestilling?
    - o Direkte til forbrukere?

Tema 1

- Kan du kort fortelle hvordan bedriften er organisert?
- Er bedriften organisert på en spesiell måte for å fremme produkt innovasjon?
    - o Hvordan? Hvorfor/hvorfor ikke?
    - o Egen avdeling for produkt innovasjon?
- Man kan gjerne skille mellom ulike typer innovasjoner - hvilken grad teknologien er ny (forbedring vs helt ny) og hvilken grad det nye produktet gir bedre kundetilfredshet enn eksisterende produkter (pr dollar). (se modell under).

TYPES OF PRODUCT INNOVATIONS

		Customer Need Fulfillment Per Dollar	
		Low	High
Newness of Technology	Low	Incremental innovation	Market breakthrough
	High	Technological breakthrough	Radical innovation

- Fokuserer dere på ulike typer av innovasjoner? (forbedring av eksisterende produkter/ helt nye produkter – new technology, new market, ulike soner for fokus)
  - o Har dere organisert bedriften på en måte slik at dere skiller mellom ulike typer innovasjon?
    - En avdeling for helt nye produkter etc.?
    - En avdeling for forbedring av eksisterende produkter?
  - o Kan du gi eksempel på et produkt dere har utviklet som var helt nytt og et som har vært en forbedring?
    - Vil du si dere fokuserer mest på å forbedre produkter eller skape helt nye produkter?

Tema 2

- Kan du fortelle litt hvordan dere driver med produkt innovasjon?
  - o Hvordan kommer dere frem til nye produkter?
    - Tilfeldig, plutselig dukker ideer opp?
      - Hvordan blir disse tatt opp og blir iverksatt?
      - Hvorfor bruker dere ikke ulike metoder/verktøy for å fremme innovasjon?
        - o Dårlig erfaring med disse? Lite erfaring med bruk av verktøy?
    - Bruker metoder/verktøy?
      - Evt hvilke?
        - o Hvordan blir de organisert/iverksatt?
        - o Hva syntes de ansatte om slike verktøy/metoder?
        - o Hvordan synes du denne metoden fungerer?
        - o Hvem er deltakende på disse metodene?
  - o Hvis dere kommer opp med et nytt produkt, hvordan organiserer dere typisk for å føre ideen videre?
  - o Hvor mange er med i utviklingsarbeidet?
    - Hvilken type kompetanse tar dere med i prosessen?
    - Hvilken grad blir kunder og leverandører involvert?

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Invitation to Participate in Interview

Background and purpose

I am currently enrolling a master's degree in industrial economics at University College of Southeast Norway and plan to conduct a study that will be my master thesis for my degree. The study is guided by associate professor Roland Hellberg. To conduct this research, I wish to perform in depth interviews of large companies that do product innovation.

About the study

The study concerns product innovation, and to limit the thesis, the focus is organizing and methods. The study is twofold and investigates how companies organize to prompt product innovation compared to how the literature suggests. I want to see if companies organize similarly to how the literature suggest; does the industry practice resemble the theory? I also want to see if this differ dependent on the size of the companies. The other part of the study is about what methods companies use for product innovation. There exists countless methods and tools to come up with new ideas and create new products, and here I would like to investigate if companies intentionally use different tools and methods for product innovation. I also wish to see if the size of the company and the innovative purpose (improve existing products / something totally new) has any effects on the result.

What does participation in the study mean?

Participation will demand about one to one and a half hours of your time, and the interview will in large be leaded by the informant. It is naturally voluntary to comment/ discuss the different themes, and all personal information will be treated confidential where only the student and supervisor will have access to it. Information about the company will be preserved anonymous in the study by being coded so they cannot be traced back to each individual firm. If it is accepted by the informant, I wish to record the interview and transcribe it afterwards.

I wish that the results from the study could be of value for companies that wish to learn more about product innovation. I am looking forward to this project, and appreciate your participation.

Best regards,

Tobias Møretrø

This study is reported to Data Protection Official for research, NSD – Norsk senter for forskningsdata AS.

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HSN   Høgskolen
i Sørøst-Norge

Invitasjon til å delta i intervju

Bakgrunn og formål

Jeg går master i industriell økonomi ved Høgskolen i Sørøst-Norge og planlegger å gjennomføre en studie som blir masteravhandlingen for graden min. Studien er veiledet av førsteamanuensis Roland Hellberg. I forbindelse med dette arbeidet ønsker jeg å utføre dybdeintervjuer av store bedrifter som driver med produkt innovasjon.

Studien omhandler produktinnovasjon, og for å avgrense oppgaven er hovedfokus organisering og metoder. Studien er todelt og går ut på å undersøke hvordan bedrifter er organisert for å fremme produktinnovasjon sammenlignet med hvordan litteraturen mener man bør organisere. Her ønsker jeg å se om bedrifter organiserer på linje med hvordan litteratur hevder det bør gjøres; stemmer teori med praksis? Jeg ønsker også å se på om dette er forskjellig avhengig av størrelse på bedriftene. Den andre delen av studien handler om hva slags metoder bedrifter benytter for produktinnovasjon. Det finnes utallige metoder og verktøy for å komme frem til nye ideer og skape nye produkter, og her ønsker jeg å undersøke om bedriftene bevisst bruker ulike verktøy og metoder for produktinnovasjon. Jeg ønsker også her å se om størrelse på bedrift og innovasjonsformål (forbedring av eksisterende produkt/ noe helt nytt) har noen effekt på resultatet.

Hva innebærer deltakelse i studien?

Deltakelse i studiet vil kreve omtrent halvannen time av din tid, og intervjuet vil i stor grad være styrt av informanten hvor det naturligvis er frivillig om man vil uttale seg om de ulike temaene. Alle personopplysninger vil bli behandlet konfidensielt, og det er kun student og veileder som vil ha tilgang til det. Opplysninger om bedrift vil bli behandlet anonymt i studien ved at det kodes slik at det ikke kan spores tilbake til den enkelte bedrift. Dersom det godkjennes av informanten ønsker jeg å gjøre lydopptak av intervjuet, samt transkribere det i etterkant.

Resultatene fra studien ønsker jeg at skal kunne være av verdi for bedrifter som ønsker å lære mer om produktinnovasjon, og som et bidrag til akademisk verdi for videre forskning. Jeg ser frem mot dette prosjektet, og setter pris på din deltakelse.

Mvh,

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Studien er meldt til Personvernombudet for forskning, NSD – Norsk senter for forskningsdata AS.