Information Processing Problems

A comparative study of the Front End of new product development within radical and incremental projects

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Industrial Management and Business Administration, 15 credits

Halmstad 2015-12-13
Acknowledgements

Writing this thesis has been a fuzzy undertaking to say the least. The journey has literary taken us to the other side of the world and back, allowing us to learn more than any single lecture ever could. For this, we are grateful.

The biggest thank-you goes to our supervisor Henrik Florén and our examiner Mike Danilovic for their honest and critical feedback, support, engagement and discussion sessions that helped us during our research process. Sometimes, the most intense discussion is the one you learn the most from.

Moreover, we would like to send our gratitude to our opponents for their effort in reviewing our paper and asking the critical questions that always eludes the author.

Finally, we would like to send a special thank-you to our friends and families who supported and encouraged us during our studies at the University of Halmstad.

Halmstad, October 2015

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Abstract

The first phase of new product development (NPD) is today commonly referred to as the Front End (FE) of NPD. The phase has received a decent amount of attention during recent years, nevertheless insufficient considering its ability to influence a project’s outcome. The phase begins when an idea is born and ends when a formal meeting decides whether to invest in the idea or not. The investment then leads the project to enter a formal phase. During the FE, a large number of issues occur, which are believed to be the result of deficient processing of information. If the issues are not managed correctly, the NPD procedure will not be efficient. When information is being processed into knowledge, sometimes an uncertain, equivocal, or complex situation arises, which leads to delays, additional costs, and wasted efforts. These information processing problems (IPPs) need to be managed by firms in order to reduce their negative repercussions. Depending on a firm’s perception of the novelty towards a product, the project is considered to be either radical or incremental. Depending on that novelty, it is theorized that the IPPs will have different dispersions, and pose differently significant challenges to the project. The aim of this study is therefore to investigate the differences of the significance and dispersion of the IPPs, during the FE, when comparing radical and incremental NPD projects.

For this purpose, a case study approach was deemed appropriate. In order to collect data concerning the IPPs, seven case studies were conducted. The data was collected through semi-structured interviews, with respondents that possess an extensive experience from working with NPD within Swedish firms.

The data analysis from the seven interviews proved that there indeed was a difference in how the IPPs vary dependent on whether the project was of a radical or incremental nature. All the IPPs showed higher levels of significance in the FE in radical projects, than in incremental ones. Uncertainty proved to be the IPP that differed the most and therefore possessed the greatest significance difference. This means that differentiated approaches in radical respective incremental projects are needed in order to reduce uncertainty. Equivocality represented the IPP with the least difference in significance, meaning that the FE in radical and incremental projects require rather similar design of how to prevent equivocal problems. By understanding the differences in dispersion and significance, can create differentiated management approaches during the FE that fit the level of novelty of the product at hand. For some products, preventive actions must be taken to a larger degree compared to others. By doing so, the lead time of the FE can be shortened as less problems will arise, creating a faster and smoother process. The resources saved could be spent on improving activities, instead of being wasted on repairing unnecessary problems. The study contributes to the research field of NPD by adding new knowledge, aiding the collective effort of increasing firm’s proficiency in how to manage the FE.

Keywords: Uncertainty, equivocality, complexity, new product development, Front End of new product development, Front End of Innovation, information processing problems.
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1 Introduction

The introduction presents the background and the base of reasoning why the study has been conducted. A comprehensive argumentative text follows, describing the problems connected to the topic and why they are relevant to investigate. The chapter culminates in a research question, after which the study design is based.

1.1 Background

Dynamic and demanding customer needs, increasing competition, and rapid changes of technologies add up to a harsh and challenging business environment (Lin & Chen, 2004). In order to survive, firms need to address these challenges in a manner that allows for sustainable competitive advantages and long-term profits (Cooper, 1996). Firms tend to turn to innovation as a method for creating sustainable and long-lasting profitability (Cooper & Kleinschmidt, 1991; Porter, 1990).

Macro innovation is a subcategory of innovation and takes place on a country’s governmental level and aims to contribute to national growth (Grossman & Helpman, 1993). A micro innovation on the other hand takes place within firm’s boundaries (ibid). Often, micro innovations are so called technological innovations that incorporates the innovations connected to engineering, applied sciences, or the so called industrial arts (Garcia & Calantone, 2001). Garcia and Calantone (2001, p. 112) define a technological innovation as “…an iterative process initiated by the perception of new market and/or new service opportunity for a technology based invention, which leads to development, production, and marketing tasks striving for the commercial success of the invention”. The definition explains the basic idea of the innovation; it is an invention that is commercialized, i.e. an invention that is introduced to a market or an area where it fulfills a need (Garcia & Calantone, 2001). Cooper (1996, p. 465) underlines the importance of technology innovations for firms, as he states: “The message to senior management is simple: Either innovate or die!” Further, Isaksen and Akkermans (2011, p. 161) mean that “Innovation is a key factor for growth and economic development”. In fact, there are multiple studies that suggest that having an innovative organization is one of the most important factors for achieving firm growth (Ducker, 1985; Kelley & Littman, 2005; Tushman, 1997).

When referring to technology innovations it is important to make distinctions between process- and product innovations. Process innovation is the development of novel or improved methods connected to organizational functions, such as production, marketing, or logistics (Rogers, 1998). Product innovation instead refers to a novel or improved product where at least one aspect of the product is significantly different from the previous one (ibid). The process of incorporating and formalizing product innovation within a firm is more commonly referred to as new product development (NPD), i.e. the process of developing a product from idea to finished product (Cooper, 1996).
NPD is not to be confused, or equated, with radical new product development, which instead is a subcategory of NPD (Garcia and Caltone, 2001). For this study, incremental and radical products represent the two subcategories of technology innovations. There are additional subcategories of technological innovations (e.g. really new, discontinuous, or imitative innovations), but recent NPD literature has elucidated and focused more on the concept of radical and incremental innovation (ibid). Radical innovation is defined as “…innovations that embody a new technology that results in a new market infrastructure” (Garcia & Calantone, 2001, p. 120). At the opposite side of the spectra, incremental innovation is regarded as a number of smaller, but still novel, improvements of an already existing product (ibid). The definition of incremental innovations, that Garcia and Calantone (2001, p. 123) offer, is as follows: “…products that provide new features, benefits, or improvements to the existing technology in the existing market”. As the name suggests, incremental NPD incorporates products that are considered incremental innovations. The same is true for radical NPD, which incorporates radical innovations.

Radical and incremental innovations are distinguished by the level of newness of the product that being developed (Garcia and Calantone, 2001). The level of newness is dependent on whose point of view one is measuring (ibid). Garcia and Calantone (2001) mention, in their literature review of innovation definitions, six different points of view that one can measure from: new to the world, new to the industry, new to the scientific community, new to market, new to customers, and finally new to the firm. For this study, the level of newness of a product will always be measured from the point of view of the firm. The level of newness is measured towards the sum of the collected knowledge of all the individuals that are participating in the NPD project. Consequently, depending on the knowledge base of the project members, the project will either be deemed as radical or incremental. Different levels of newness in a NPD project needs to be managed in different ways, meaning that firms should have differentiated designs of their NPD processes depending on if the project is of a radical or incremental nature (Durand, 1992).

It is proposed in literature that NPD (both radical and incremental) is a vital process for firms to become and remain successful, meaning that firms must renew or upgrade their product portfolio as not to perish (Lin & Chen, 2004; Brown & Eisenhardt, 1995; Kessler & Chakrabarti, 1996). It has been suggested that one of the quickest and most efficient ways of gaining a competitive advantage in NPD is to introduce innovative products faster than the competition, which indicates that the lead time of NPD projects needs to be shortened to the lowest possible level. During the last decades, a trend of reduced lead times has influenced the way firms manage their NPD (Smith & Reinertsen, 1992; Cooper, 1996; Lin & Chen, 2004). Reduced lead times in NPD enables a higher return on R&D-investments, leads to more frequent and successful market introductions, and increases the changes of gaining market shares (Smith & Reinertsen, 1992). The speed of NPD projects also directly affects the overall cost of the NPD, both in time and money (Kessler, 1996).

Many large firms manage their NPD with a systematic and structured approach in order to make the process as efficient as possible. One such popular approach is the Stage Gates model (Griffin,
1997; Cooper & Kleinschmidt 1991), which has been documented to be used by prominent firms such as Procter & Gamble, Emerson Electric, ITT, and 3M (Cooper, 2008). With the assistance and guidance of such a tool, firms ensure that the allocated resources are being used in an efficient way (ibid). One important function of having a well-defined and structured NPD process is to minimize uncertainty that is connected to many aspects of the product (ibid). In other words, the more structured the project becomes, the more clear and straightforward the progress (ibid). At least that is the idea. Some research suggests that the more structure one enforces, the more bureaucratic and creative hampering the process becomes (ibid). However, to some extent, a clear structure helps to ensure that competitive products are being introduced to the market while terminating those that show less promise (ibid).

During the last couple of decades more attention has been dedicated to understand and manage predevelopment activities of NPD (Smith & Reinersten, 1991). Those are the activities that are being conducted before the first formal project meeting and correlates to the earliest parts of the NPD process (Khurana & Rosenthal, 1997). This early phase of the process is commonly referred to as the Front End of Innovation (FEI), or simply the Front End (FE) (Koen, Ajamian, Burkart, Clamen, Davidson, D’Amore, Elkins, Herald, Incorvia, Johnson, Karol, Seibert, Slavejkov, Wagner, 2001). Due to the focus of this study, this phase will be referred to as the FE, indicating the Front End of NPD. The FE represents the early NPD phase where ideas are born and identified, and later conceptualized, resulting in a go/no-go decision on whether or not the informal project should move into a formal one (Kijkuit & Van Den Ende, 2007; Khurana & Rosenthal, 1998). Broadly speaking, the FE begins when a product opportunity is first considered, and ends when the decision is made to move into a formal development of the product (Kim & Wilemon, 2002). During this phase, typically no formal meetings are held and information of all the activities is restricted (ibid). Just as the FE only represent a part of the NPD process, so too can the FE be further divided into sub phases. The division is made because product development needs be managed differently depending on where in the process a product currently is. However, how this division will look depends on what type of firm it belongs to and which type of product that is being developed. In order to keep this study general and suitable for many firms, the FE will not be divided into sub phases, but will instead be treated as one phase.

Researchers have since long been aware of the importance on the early informal phases of NPD, but it was not until the early 1990’s that substantial efforts were put into the research area (Smith & Reinersten, 1991). The FE phase is critical for several reasons. In the FE there are multiple decisions and considerations made, which have a huge influence to the outcome of the project (Frishammar & Florén, 2008). The foundation for success or failure is established in this phase since even small actions may cause repercussions of great magnitude (ibid). This is partly due to the fact that small issues in early stages tend to grow to large ones as the project progresses (Bacon, Beckman, Mowery, & Wilson, 1994). It is also partly due to a misallocation of managerial attention (Danilovic, 1999). Figure 1 illustrates one of the findings of a study conducted at Saab AB, a Swedish car and aircraft manufacturer (ibid). As Figure 1 suggests, managers tend to pay the most attention to a project during the later phases of the project (ibid).
According to the graph, the earliest stages (the FE) of a project represent the largest opportunity to influence the outcome of the project (ibid). However, as managers only pay attention to the project towards the later phases, this opportunity is forfeited (ibid). This imbalance of attention could become troublesome for firms as additional costs will arise if major changes are made in later phases of the NPD project.” Frishammar and Florén (2008) pinpoint the issue, and its relevance, when they propose that many firms lack proficiency in how to manage the informal and uncertain FE-phase.

![Graph showing managerial attention and ability to influence](image)

**Figure 1. Managerial attention and ability to influence (Danilovic, 1999)**

### 1.2 Problem formulation

Koen et al. (2001), points out that the FE indeed represents an important challenge of NPD. Florén and Frishammar (2012) estimate that the FE has put several high performing firms into difficulties. Despite the many challenges associated with the FE, the phase represents one of the greatest opportunities for improvements, not the least as a tool for shortening the total lead-time of a project (Koen et al., 2001). Another relevant challenge of the FE is that firms must be able to identify and separate promising from non-promising opportunities before any major investments are assigned to it (ibid). If a firm misallocate its resources to failing projects, the cost will be greater than the value created (Urban & Hauser, 1993; Griffin, 1997; Calantone, Benedetto, & Schmidt, 1999). For example Hasselblad, a Swedish camera manufacturer, almost went bankrupt due to a misguided product screening of its product proposals in the FE (Florén & Frishammar, 2012). Hasselblad terminated the early attempts at the digital camera, which allowed competitors such as Nikon and Canon to move in and claim large portions of the market shares (ibid). Xerox also failed to profit from emerging technologies at their research facility Palo Alto Research Centre, due to a deficient product screening during the FE (Chesbrough, 2007).
There is not one factor that in itself is responsible for the chaotic nature of the FE. However, literature suggests that the way firms process information to create knowledge affects the outcome (Chang, Chen, & Wey, 2007). As firms meet the many challenges of the FE, they need additional knowledge in order to overcome the obstacles (ibid). Firms need to acquire information about its constantly changing surroundings and process it so that it becomes manageable and applicable knowledge (Zack, 2000). By doing so, firms can recognize knowledge as a strategic asset and more easily meet the challenges associated with the FE (ibid). This reasoning derives from the idea that the more relevant knowledge one has, the easier specific issues can be resolved (ibid). In order to avoid the many pitfalls, firms implement so called knowledge management programs to structure the process of acquiring information and processing it (ibid). However, for many firms, these programs have yielded no reward (ibid).

Prior research suggests that firms actually do have major problems in processing information in the FE (Florén & Frishammar, 2012). Problems of processing information into knowledge can have dire consequences for the progress and result of the entire project. For example, if a project team in the FE lacks knowledge to complete the task, or they interpret (process) the information incorrectly, the success of that project becomes jeopardized (Chang et al., 2007). If not managed in a satisfying way, information processing problems (IPPs) will arise and cause additional costs, time delays, and waste of efforts (ibid). For example, firms run a great risk of suffering from those consequences if wrong or faulty information is processed, resulting in incorrect knowledge. There are several kind of IPPs that need to be considered (Zack, 2000). In Chapter 2.4, the IPPs are further elaborated and described.

As previously mentioned, some firms acknowledge the issues connected to information processing and therefore implement so called knowledge management programs, but as these have not yielded the sought after outcome, something seems to be amiss. It is suggested that this is due to faulty management approaches (Durand, 1992). The fact that different kinds of NPD projects require different forms of management, could explain this phenomenon (ibid). This leads back to the concept of radical and incremental NPD. As radical and incremental projects differ in several aspects, the way they should be managed differs as well. More precisely, distinctions need to be made between how they process information and what IPPs that influence that process. It could be hypothesized that different kind of IPPs are more or less prominent in radical and incremental projects and if firms could fully understand how often and how severe the IPPs are, they could find alternative methods of approaching the FE of NPD projects.

Since acquiring knowledge is essential for firms to remain competitive (Grant, 1996; Szulanski, 1996), the IPPs in the FE should not be left unchecked. If they can be managed and reduced, the FE will progress smoother and result in shorter lead times. As a result, firms will be able to innovate in a faster and more frequent manner, and as well become more profitable. The research area regarding IPPs in the FE has been partly empirically explored (Frishammar, Florén & Wincent, 2011; Koen, et al., 2001; Chang et al., 2007), but further investigations are needed to fully understand the importance of the IPPs and the demand for efficient FE management that it requires. For example, there is limited research that empirically investigates IPPs in the FE,
which also compares the difference in radical and incremental NPD projects. By studying the frequency in which the IPPs occur, and what negative impact they might have on the project, a distinction between radical and incremental projects could be made. By using these two measurements an indication could be made of the significance that the IPPs play in the FE. Naturally, those IPPs that have the highest frequency and impact combined are those that show the highest level of significance, and therefore need the most immediate attention. If there is a difference between radical and incremental projects, in terms of the IPPs significance, a new approach of managing knowledge acquisitions in the FE needs to be developed so as to fit the specific project type at hand.

1.3 Purpose and Research Question

The purpose of this study is to investigate if there is a difference in how the IPPs’ significance varies in radical and incremental projects within the FE. It also aims to explain those possible differences in significance, and what those differences mean. By doing so, this study could contribute to the field of NPD research in assisting researchers to find a more proficient way of managing the FE. This would result in faster and cheaper NPD projects enable firm growth and long-term profits. This reasoning is the foundation on which the research question of this study is resting upon. Based on that foundation, the research question of this study is:

*How do information processing problems vary, in terms of significance, in the Front End of new product development when comparing radical and incremental projects?*

1.4 Disposition

This thesis consists of 6 chapters, which disposition and content are briefly described in this section.

*Chapter I* initiates the thesis with and Introduction to the chosen topic. The introduction is divided into a background, a problem formulation, and a purpose and research section. The two first parts guides the reader trough reasoning and argumentation, resulting in the purpose and research question of the thesis.

*Chapter II* presents the Theory used, and prior research done, which is needed to give the reader an understanding to the field of research. The chapter starts off by giving the reader information about NPD and FE, and moves thereafter forward by introducing the concepts of what information and knowledge is. The chapter is rounded off by discussing different IPPs, which will be used in the remaining parts of the thesis.

*Chapter III* describes the Methodology used to conduct the research for the study. The strategies, approaches, and choices made will be presented here. Discussions are held concerning the study’s trustworthiness and critics are deliberated in order to guarantee a high quality.
Chapter IV contains the **Results and Analysis** of the gathered empirical data from the multiple-case studies. In this chapter, data is firstly presented from the seven different interviews. After that, the data is analyzed and presented in several different graphs, which visualize the analyzed data in a more pedagogical manner.

Chapter V takes the results of the analysis and has a **Discussion** about the ratings and complementary quotes from the respondents. Discussions are held regarding the conclusions of each IPP, and the difference between them.

Chapter VI is the concluding chapter, which summarizes the findings and presents the **Conclusions** of the study. The chapter is rounded off by describing the managerial and theoretical implications of the findings, and how these could lead to further research.
2 Theory

Prior chapter introduced several concepts, which the research question is based upon. In order to create further understanding of the subject, relevant theories are presented in this chapter. The theories together create an understanding of the study’s area of focus, enabling a data analysis based on prior research, rather than on speculations.

2.1 New product development

New product development refers to the process of designing, developing, and creating new products, with the final aim of introducing them to the market (Cooper, 1996). In other words, it is the process of developing a product from an idea to finished product (ibid). The definition of a product differs depending on what area one is studying (Kotler & Keller, 2006). In the field of marketing, a product is anything that can be offered to a market, which also satisfies a want or need (ibid). From an economic point of view, a product is referred to as either a physical good or an intangible service (ibid). Goods are items that can be touched and handled, such as footballs, salt, or chairs. A service is a product that cannot be touched and is often performed by another person or interactive machine, such as doctors, dentists, or gardeners (ibid). Prior research concerning NPD, normally focuses on physical goods rather than intangible services (ibid). This study will therefore follow that example as the field of topic is most relevant for goods.

The structure of a NPD project depends on several aspects (Griffin, 1997). Obviously, the nature of the product, and its attributes, is one of these aspects (ibid). One popular way, seen in Figure 2, of organizing the NPD is to follow the structure of the Stage Gate model and the six phases that it proposes (Cooper, 2008; Cooper & Kleinschmidt 1991). The model is in itself not essential for this study, but is rather used as a demonstrative tool, showing how a typical NPD project could be structured. The model is introduced so that it is clear which kind of activities that belongs to the FE, and which does not. It is necessary to understand which activities that are conducted in a typical NPD process in order to understand their implications.

![The Stage Gate Model of NPD](image)

Figure 2. The stage gate model (Cooper, 2008)
The first three phases of the Stage Gate model is commonly known as the pre-development activities, and directly corresponds to the activities being conducted in the FE (Koen, 2004). The first phase (1) Discovery, is the process of identifying and generating ideas for new products (ibid). During the second phase (2) Scoping, the product idea is evaluated in its strengths and weaknesses, towards the sought after market’s properties and attributes, i.e. if the product will fit the market or not (ibid). In the third phase (3) Build business case, four major activities are conducted: product analysis and definition, building the business case, creating a project plan, and establishing a feasible review (ibid). Moving out of the pre-development activities, the fourth phase (4) Development, is the first step of the formal product development (ibid). Here the plans are put into action and the product design is being finalized and tested (ibid). In the fifth phase (5) Testing and validation of the product takes place (ibid). A comparison is made between the original goals of the product, and whether or not it fulfills them (ibid). Finally, as a sixth step, the product is launched to the market (ibid).

### 2.1.1 Radical and incremental NPD

In new product development there are several aspects that are essential to consider. While trying to define what the new product will entail, assessments of the customer’s and user’s need must be conducted, risks and opportunities must be weighed against each other, the competitiveness of the product needs to be considered, and cost versus profit calculations should be made (Bacon et al., 1994). The list of activities in NPD projects is long, thus it is not surprising that the NPD process is both time consuming and costly (ibid). What activities that should be included, and the amount of effort that should be invested, differs depending on the nature of the project and the firm executing it (ibid). Consequently, different NPD projects require different managerial approaches in order to reach proficiency (Durand, 1992). The need of differentiated approaches becomes more evident when comparing the level of novelty of the product at hand (ibid).

Incremental innovation, which is incorporated in incremental NPD, consists of a number of minor, yet novel, improvements of an already existing product or technology (Garcia & Calantone, 2001). Garcia and Calantone (2001, p. 123) define incremental innovations as “…products that provide new features, benefits, or improvements to the existing technology in the existing market”. If the product being developed instead possesses properties that are considered new to the firm, it will be considered as a radical innovation in a radical project (ibid). In contrast to incremental innovation, the radical one is defined as “…innovations that embody a new technology that results in a new market infrastructure” (Garcia & Calantone, 2001, p. 120). Note that the definition of radical innovation adds infrastructure at the very end. Radical innovations do not necessarily have to result in a completely new market, more than often the old market conditions are transformed (change of infrastructure) into something that shift the rules of the industry (ibid).

As previously mentioned, for this study the level of newness of a product is decided from the firm’s point of view. However, it can be argued that the concept of radical and incremental NPD are relative terms, as the firm’s background and prior knowledge decide the experienced novelty.
of the product. For example, if the camera manufacturing firm, Canon, would initiate a NPD project with the aim to upgrade one of their optic devices, it would most likely be deemed as an incremental project, as they already possess knowledge connected to that specific technology. However, if the same project would have been conducted by the car manufacturer Audi, it would be regarded as a radical project, as Audi does not possess knowledge in optics technology. The way Canon and Audi would approach and manage the optics project would be diversified. Different levels of newness in a NPD project needs to be managed in different ways, meaning that firms should have differentiated designs of their NPD processes depending if the project is of a radical or incremental nature (Durand, 1992).

2.2 Front End of new product development

During recent years more focus and effort have been put into understanding and improving the activities taking place in the very beginning of NPD (Kijkuit & Van Den Ende, 2007). The first phase of NPD, called the Front End, stretches between the formulation of an idea and until the first formal meeting (Smith and Reinertsen, 1991; Koen et al., 2001). The “first formal meeting” refers to the point in time where it is decided whether or not further efforts and capital should be invested in the project (Khurana & Rosenthal, 1997). In other words, the FE represents the early NDP phase where ideas are born and identified, and later conceptualized, resulting in a go/no-go decision on whether the informal project should move into a formal one (Kijkuit & Van Den Ende, 2007; Khurana & Rosenthal, 1998; Kim & Wilemon, 2002). The FE aims to generate and screen a sustainable flow of ideas (Boeddrich, 2004).

The FE was previously known as “The fuzzy front end”, but lost its “fuzziness” once the field got more explored (Koen et al., 2001). Researchers claimed that the word “fuzzy” would suggest that the early phase of NPD is driven by unknowable and uncontrollable factors (ibid). This, incorrect, interpretation of the word would have relieved researches and managers from accountability of the outcome of the phase (ibid). Instead the term FE was coined to amend this misconception.

Low levels of formality and lack of documentation typically characterize the FE (Smith & Reinertsen, 1991). Overall, the phase is considered as informal and difficult to keep track of (ibid). For example, ideas or concepts might be discussed in the canteen or in the hallway since there seldom are any formal meetings held. This indicates that even if, for example, the Stage Gate model was incorporated with the FE, the process would still be difficult to manage as it is considered as highly informal. These attributes add up to an uncertain environment that often is visualized in accordance with Figure 3. The figure describes the contrast between the informal, “fuzzy” FE, compared to the formal sub-sequential phases of NPD that are considered to be more clear and easier to understand and structure.
Researchers and firms have since long acknowledged the importance of the FE, but it was not until the early 1990’s that substantial efforts were put into researching the area (Smith & Reinertsen, 1991). The importance of the FE has gained much attention lately by managers and researchers due to the opportunity of shortening the total lead-time of the entire NPD (ibid). If the FE is understood and approached accordingly, less capital and resources would be wasted, leading the firms to have a faster and more competitive NPD process (Smith & Reinertsen, 1992; Cooper, 1996; Lin & Chen, 2004). It is suggested in literature that the FE phase represents the greatest opportunity of improvements for the overall NPD performance and lead-time reduction (Backman, Börjesson, & Setterberg, 2007). At the same time, the FE is also one of the biggest possible pitfalls one may fall into (Cooper, 1988). This contradiction derives from the fact that the FE lays the foundation for the failure or success of the final products (Frishammar & Florén, 2008; Cooper, 1988). Even the smallest action might have repercussions of great magnitude (ibid).

Literature covering the different aspects of the FE are, to say the least, limited (Kim & Wilemon, 2002). The undeveloped knowledge connected to the FE can be explained due to the lack of formalization of the phase (Murphy & Kumar, 1997). The phase is by its nature hard to study, which is why researchers in the field find it difficult to create a picture of its content and attributes to agree upon (ibid).

### 2.3 Information and knowledge

The terms *information* and *knowledge* are often inaccurately used as interchangeable concepts (Nonaka, 1994). However, according to scholars and epistemology teachings (the theory of knowledge) there is a clear distinction between the two (ibid).
Information is data that one can access in order to gain understanding of a specific item or entity (Nonaka, 1994). Nonaka (1994, p. 15), in his work *A dynamic theory of organizational knowledge creation*, refers to the old explanation “Information is a flow of messages or meanings that might add to, restructure, or change knowledge”. Dretske (1981, p. 44) gives an alternative definition: “Information is that commodity capable of yielding knowledge, and what information a signal carries is what we can learn from it”. The unifying denominator between the two definitions is that information can create or influence knowledge. Information is the construction blocks that knowledge is built upon (Galbraith, 1977).

Knowledge is a multifaceted and controversial concept (Zack, 2000). Knowledge is not something that can be touched; it is an asset of the mind (ibid). Some knowledge can easily be taught to others, while some knowledge needs to be experienced or reached via reasoning of individuals (ibid). The true meaning of knowledge is still unclear, but there have been countless attempts by learned men and women, over millennia, trying to find a common definition to unify on (Nonaka, 1994). Grant (1996, p. 110) puts it like this: “Since this question (of what knowledge is) has intrigued some of the world’s greatest thinkers from Plato to Popper without the emergence of a clear consensus, this is not an arena in which I choose to compete”. However, according to traditional epistemology reasoning, which many and more researchers leans on, knowledge is defined as a “justifiable true belief” (Nonaka, 1994, p. 15). However, for this study, a more simplified definition will be used. It is the definition that Grant (1996, p. 110) decided to adopt, which describes knowledge as “That which is known”. This decision is made to circumvent the issue of the epistemology’s choice of wording its definition of knowledge. The issue lies in the concept of truth of justifiable true belief. It could be argued that knowledge does not have to be universally true, as long as the individual believe that the knowledge is true. It lies in the mind of the observer to say what knowledge is true and what is not. In contrast, the definition that which is known makes no distinction between true or false, but assumes that knowledge (information that has been processed and “approved” by the individual) is true in the eyes of the observer. By adopting the latter definition, less room is given for misinterpretations and debate.

In sum, information is a flow of messages (or data), while knowledge is created, reshaped, and influenced by that very flow. Knowledge is something that is known and anchored to the perceived trueness of its observer.

### 2.4 Information processing problems

It is clearly stated in prior literature that managing knowledge is essential for staying competitive, and that firms should address it during their work revolving NPD (Grant, 1996; Szulanski, 1996). The more proficient a firm becomes in processing information, i.e. acquiring information, processing it, and reshaping it into applicable knowledge, the bigger their competitive advantage (Grant, 1996). However, many firms experience issues while managing their knowledge (ibid).
Several authors have discussed, or explained, the concept of knowledge management in terms of information processing, but none of them kept to a single easily comprehensible designation of the concept. For this paper, the term information processing problems (IPPs) will represent the difficulties that arise while firms are trying to process information into knowledge. It is important to note that IPPs in itself is not a new concept, but has been studied over a long period of time (March & Simon, 1958). However, in terms of IPPs in NPD, and especially in the FE, research has only made progress the last couple of decades.

There are several kind of IPPs, which all cause different kind of challenges. Prior research and literature has failed to reach consensus of which IPPs that are more crucial than others in NPD. Some research has shown that different IPPs are more or less important in different phases of the NPD. For example in Frishammar’s et al., (2011) article Beyond managing uncertainty: Insights from studying equivocality in the fuzzy front end of product and process innovation projects, they find empirical support that some IPPs in fact causes more problems than others during different activities in the FE. However, their study only highlights, and investigates, two different IPPs, whereas other researchers propose that a total of four different IPPs need to be taken into account (Chang et al., 2007). In order for researchers to reach further conclusions, it would be advantageous to first reach a consensus on what kind of IPPs there are, and how they could be defined. Up to this day, literature has failed to do so, as different authors offer different explanations and definitions of IPPs that are each other’s namesake.

Several IPPs have been identified throughout our literature review; the following five is the most prominent: Uncertainty, Variability, Equivocality, Complexity, and Ambiguity (Chang et al., 2007; Frishammar et al., 2011; Zack, 2001; Khurana & Rosenthal, 1998; Law, 2014). Since their definitions and meanings are different, a short argumentation will follow to select those of relevance and importance for this study.

Historically, extensive research has focused on studying (1) uncertainty (Frishammar et al., 2011; Moenaert, De Meyer, Souder, & Deschoolmeester, 1995), which can be described as the gap in knowledge of what one has, and what one needs in order to complete a task (Galbraith, 1973). This gap in knowledge (uncertainty) is a relevant phenomenon in several situations. One example is when a person is trying to predict the multiple possible future outcomes of an action (Garner, 1962). Since the future is impossible to perfectly predict, the situation will always have a certain amount of uncertainty. Dosi and Egidi (1991) add more by proposing that uncertainty also incorporates the lack of ability to process relevant information. Simply when one lacks the knowledge to process another piece of information (in order to process item B, one must first understand piece A).

Chen et al. (2007, p. 474) use the IPP (2) variability, which they define as “the rate of change and the intensity of change”, meaning that things change over time and therefore poses a problem in managing information that is dynamic. In other words there is an uncertainty in how things will change over time and the future is therefore unclear and hard to predict. So henceforth,
throughout this paper, the concept of variability will be considered irrelevant as it falls under the definition of uncertainty.

The IPP (3) equivocality refers to a situation where multiple interpretations of a specific item exist (Frishammar et al., 2011; Daft & McIntosh, 1981; Chang et al., 2007). Equivocality does not stand in conflict with, or oppose, any other IPP and is therefore considered as a valid concept to be studied by its own significance.

Pich, Loch and Meyer (2002, p. 1013) define (4) complexity as meaning “that many different actions and states of the world parameters interact, so the effect of actions is difficult to assess”. Zack (2001, p. 3) refers back to Simon’s (1969, p. 195) more simplified definition as he defines complexity as “a large number of parts that interact in a no simple way”. Complexity has been identified by prior researches as being a part of uncertainty (Galbraith, 1973). However, more recent studies points out that complexity, in itself, is a valid concept that needs to be recognized (Pich, et al., 2002; Dosi, 1988)

Ambiguity represents the inability to make sense of or interpret something (Weick, 1979). Ambiguity has previously been credited as an IPP by its own significance (Chang et al., 2007). However, it could be argued that ambiguity actually could be incorporated into uncertainty, equivocality, and complexity. Firstly, Weick’s (1979) definition of ambiguity is strikingly similar to Dosi and Egidi’s (1991) definition of uncertainty: “The lack of ability to process relevant information”. Secondly, the root cause for an inability to make sense of something might be that the item being processed is too complex or equivocal, i.e. it is too comprehensive or the meaning of the item is unclear or in conflict. Thirdly, if something does not make sense it might be that incorrect information has been acquired, i.e. an uncertain situation. Ambiguity will therefore not be considered in this paper.

In sum, for this paper three IPPs will be accounted for and explained in detail: uncertainty, equivocality, and complexity. In reality these three concepts do not exist in isolation in NPD, but influence, and interact with, each other constantly (Zack, 2001). However, they need to be studied separately in order to make sense of them and understand their importance to NPD projects, an especially the FE (ibid).

2.4.1 Uncertainty

Literature has failed to unify on a definition for the concept of uncertainty, and different definitions can be identified depending on the context in which uncertainty is presented. However, there are some definitions that are more commonly referred to than others. Uncertainty represents the gap in information of what one has, and what one needs to complete a task (Galbraith, 1973; March & Simon, 1958). Garner (1962), in his definition, includes the issue of multiple future outcomes of an action and how it is nearly impossible to foresee them. According to Dosi and Egidi’s (1991) definition of uncertainty, it also includes the lack of ability to process relevant information. I.e. the information acquired/developed by the firm “makes no sense” to the
recipient as he or she lack an ability to understand it. For this paper, above definitions will all be considered and incorporated to represent uncertainty.

Uncertainty has been a central concept of organizational theories, where it becomes relevant when trying to explain the nature of the relationship between the organization and its environment (Thompson, 2011; Duncan, 1972). The general idea is that uncertainty “concerns environmental interpretations or perceptions by individuals related to an organizational effort” (Milliken, 1987). One of many implications from prior research is that managers and participants should pay attention to, and be aware of, situations in the NPD that have a high level of uncertainty (Moenaert et al., 1995). If not addressed and reduced, uncertainty can indeed create major problems for the firm, organization, or the project itself (Frishammar et al., 2011). The main issue with high levels of uncertainty in NPD is that it exposes the project with a high degree of risk, which increases the changes of failure and, in extension, leads to high costs (Weick, 1995). More specifically, research has shown that a high degree of uncertainty is a contributing factor to difficulties experienced in the FE (ibid). Uncertainty connected to technical aspects negatively influences the process of design and the development of prototypes (Souder, Sherman, & Davies-Cooper, 1998). Market uncertainty influences the firms forecast accuracy in terms of developing a product suited for the target customers (ibid). These are but few examples of how uncertainty affects the FE in a negative way. In short, there are numerous reasons to expect difficulties in the FE if the level of uncertainty is high and if that uncertainty is not addressed and reduced (Frishammar et al., 2011).

Uncertainty can be managed in two different ways. However, a mix of the two is perhaps the most common approach. Either the firm reduces uncertainty or it increases the organizations ability to tolerate it (Zack, 2001). Gathering of more information reduces uncertainty (ibid). Alternatively, the firm could develop an ability to better predict or estimate the future (ibid). As the firm collects more information, it becomes possible to narrow down the possible outcomes of an action (Mason & Mitroff, 1974). The fewer future outcomes/states the lower the uncertainty becomes (ibid). In order for a firm to be able to tolerate uncertainty it can create information and resource slack in the organization (Galbraith, 1973). This slack will act as a buffer for eventual complications (ibid). In addition, the firm can develop an ability to quickly respond and act upon complications were uncertainty is the cause (Thompson, 2011; March & Simon, 1958). With developed intellectual resources and capabilities firms will be able to predict, estimate, and learn from complications. In order for this to work, firms must establish a communication network that transfers information efficiently, and which works smoothly and adapts to the unexpected (Zack, 2001).

2.4.2 Equivocality

The IPP equivocality refers to a situation where multiple interpretations of a specific item exist (Frishammar et al., 2011; Daft & Mcantosh, 1981; Chang et al., 2007). Equivocality often leads to confusion, disagreements, and a lack of understanding for the situation (Daft, Lengel, & Trevino, 1987). Terms such as “bad weather” or a “good leader” are equivocal. Even if all persons
involved are familiar with the concept, many interpretations can be made about it. Bad weather could be a snowy blizzard in Scandinavia, or a sandstorm in North Africa. A good leader is also equivocal since persons prefer different attributes in leaders depending on the task at hand or the environment that surrounds them. Each individual has unique experiences, capabilities, values, backgrounds, and knowledge, which frequently leads to that persons draw different conclusions and make different interpretations about a specific item or an event (Weick, 1979).

Another dimension of equivocal interpretations is connected to the fact that some knowledge is dynamic and therefore changes over time. An equivocality situation will arise when information is transferred and interpreted incorrectly, due to an unclear explanation or that the knowledge is out of date. In a case of explaining to a colleague how to best operate a machine, different opinions of best practice will emerge depending on who offers the explanation. What was best practice yesterday may not be the best practice today, as knowledge evolves. Often, individuals are unaware that equivocal situations even exist until a mistake is made as a result of that misconception. As equivocal knowledge creates problems for both the individual and the firm, it is important that it is managed and reduced. (Zack, 2001)

In NPD projects where equivocality is high, project members are unsure of what questions to ask (March, Olsen, Christensen & Cohen, 1976). This is because the situation or knowledge might be so ill defined that the answer to the question is rendered irrelevant since each recipient will make his/her own interpretation of it (ibid). Frishammar et al. (2011) point out the negative influence of high degrees of equivocality in NPD, especially in the FE, when they state that it hinders the process of project planning.

In order to reduce equivocality in the FE, cycles of interpretation, interactive discussions, and conversations on the topic, are needed to reach agreements (Weick, 1969). However, forcefully enforcing a interpretation that all should be agreed upon might cause the definition to be incorrect as the discussion might have been prematurely interrupted (ibid). Therefore, it is of the essence that the, previously mentioned, cycles of interpretations, are given space and time as to make sure that the group find an interpretation that they all feel comfortable with (March, 1978). One major difference between equivocality and uncertainty is in the manner of how it is reduced. In order to be reduced, uncertainty firstly requires the acquisition of additional information, while equivocality instead necessitates the exchange of subjective interpretations between project members (Daft et al., 1987). The main problem with equivocality is not that the world is imperfectly understood and that additional information will resolve it. The problem is rather that additional information might create even more equivocality than before, as more interpretation of the same subject will be made (Weick, 1995). Instead, firms need to construct a framework of clarifying interpretations that unify the participants and help them move forward in their work (Daft et al., 1987).

2.4.3 Complexity

Complexity refers to a variety of different elements that all are in relation to one another in an intricate way (Pich et al., 2002). Previously mentioned definition by Simon (1969, p. 195), reused
by Zack (2001, p. 3), clearly defines the concept as “a large number of parts that interact in a non simple way”. In the study by Chang et al. (2007), complexity is being referred to as “the range of difference in and the amount of interdependence in the front-end environment, means, goals, and their casual relations”. The definition is partly based on learning’s from the study by Carlile (2002), who describes several situations regarding complexity. An example from the study is when novel products are being developed; they will often require cross-boundary challenges (ibid). These situations require individuals that are capable to revise their own knowledge, but as well to influence or transform the knowledge of other functions into a mixed function or design (ibid). The differences in knowledge, values and experience may cause confusion and lack of understanding when dealing with problems like this (ibid). Similar to the definition by Simon (1969), Pich et al. (2002, p. 1009) define the concept as “an inability to evaluate the effects of actions because too many variables interact”. In other words, it means that interactions between different actions and situations make the effect of the actions difficult to assess (Pich et al., 2002).

All parts in a project might be perfectly clear separately, but as they are combined the problem is simply too complex for the project team to comprehend (ibid). Consequently, sufficient knowledge might not be satisfactory as a solution of a complex problem. Recent studies therefore distinguish the terms of uncertainty and complexity, whilst in prior research complexity has been argued to be an important element of uncertainty (Chang et al., 2007).

When a firm is capable of managing all the elements that create a complex situation, it bears a greater information processing capacity, which thus provides increased competitive advantage (Zack, 2001). Barney (1991) and Lippman and Rumelt (1982) suggest that sustainable competition partly is based on inimitable capabilities, such as resources, potential substitutes to resources, and how capabilities are implemented. Many successful firms have been noted to have a high degree of complexity within the firm; as it can be hard to recognize it, the market undervalues it (Lippman & Rumelt, 1982). According to Grant (1991) complexity is hard to imitate and understand due to the diversity, intricacy, and the tight relationship between these factors. It is more difficult to comprehend a complex pattern of coordination between a large numbers of resources, then when something rests upon a single dominant resource (Grant, 1991). Depending on the size of the project, the level of complexity changes (Kim and Wilemon, 2002). The size depend on factors such as technology, possible components, designed functions, or communication between modules (Chang et al., 2007).

An organization can choose a relatively simple view of its competitive landscape to manage complexity, such as having a narrow product portfolio (Zack, 2001). Firms with a more complicated, i.e. more complex, organization structure can map their product portfolios into simpler subunits (ibid). In that way, routines and communication can be easier, as it is less complex and more limited (ibid). Additionally, if it is well organized, each unit will be able to manage their own coordination, and little communication will be required between units (ibid). Due to an increased environmental complexity (more complex demographic and geographic markets), the complexity within organizations have increased even more (ibid).
Weick (1993, p. 641) quotes the description of Meacham (1983) that follows: "Each new domain of knowledge appears simple from the distance of ignorance. The more we learn about a particular domain, the greater the number of uncertainties, doubts, questions and complexities. Each bit of knowledge serves as the thesis from which additional questions or antithesis arises. Consequently, it is of importance to be able to manage that complexity (Zack, 2001).

If sufficient information being processed into knowledge cannot be obtained to solve a complex problem, the elements involved must be broken-down separately in order to be reduced (Zack, 2001). This strategy is useful for inherently decomposable tasks (ibid). Problems can also be restructured or redefined, creating a simplified and more comprehensible situation (ibid). Integration of expertise is a third way of managing complexity (ibid). Both cooperation with experts and limitation or simplification of views are required for non-decomposable tasks (Driver & Streufert, 1969). A common way of reducing complexity in this way is to hire consultants who possess knowledge that the firm does not (ibid).

In order to manage complexity and to make the problems more familiar and understandable, organizations need to locate and develop the expertise, skills and knowledge that is needed to be capable of handling the issues or restructure the problems or routines (Zack, 2001).

2.4.4 Measuring IPPs

In order to find a difference that can help firms to locate and evaluate the significance of the IPPs, a means of measurement must be determined. Sometimes known under different aliases, the concepts of frequency and impact are two parameters that will give an indication of the magnitude of the positive or negative outcome of any single issue (Britsman, Lönnqvist, & Ottosson, 1993).

For this study frequency represents how often an IPP occur, and is therefore measured after the amount of times a problems has occurred. As most firms do not count or keep logs of how often the IPPs occur, a perceived frequency will be measured from in terms of “very seldom” up to “very often”. Impact represents the magnitude or severity of an IPP, independent of how often it occurs. Impact represents the effort, time, or capital wasted as a consequence of the occurrence of an IPP. The resources spent on reactively correcting the problem are also included. As time, capital, or effort is measured differently, impact cannot be measured in terms of hours or currencies, but will instead represent a combined “negative effect” on the project. The effect will therefore be measured in terms of “very small”, to “very large”

The two parameters, frequency and impact, are interesting to study separately, but it is first when they are combined that the true degree of their importance becomes apparent. For example, if one knows that a certain problem arises often, but the impact of that problem is small, is it then even worth to bother? Respectively, if a problem creates major difficulties, but occurs only once, should a firm act? The questions above are more of a rhetorical nature as they can only be answered once one has all the facts on the table. However, it is those IPPs that occur often and have a large impact, which should be eliminated first.
For this study, those IPPs that have a high degree of both frequency and impact are considered to have a high level of *significance* to the project. Significance is therefore a measurement, or the product of the combined values of frequency and impact, representing how crucial or important that IPP is to eliminate in order to have a smooth FE.

### 2.5 The theoretical area of focus

In order to reach conclusions relevant to the research question, several theories were combined and have worked as a base, on which the empirical data were applied. As Figure 4 suggests, the study focuses on the NPD process, and more specifically the pre-activities, i.e. the FE. A distinction was made between radical and incremental projects so as to be able to find differences between them. The difference being investigated is connected to the three IPPs: uncertainty, equivocality, and complexity. The difference of IPPs in radical and incremental projects will therefore be measured (or weighed on the metaphorical scale) in terms of their significance to the project, which is based on the frequency and impact of each IPP.

![Figure 4. The study’s area of focus](image)
3 Methodology

In this chapter the methodological approach used for data collection and data analysis are presented. With emphasis on the methodological choices derived from the research question and the aim of the study, the chapter clarifies how the research has been conducted in order to gather the information needed.

3.1 Research approach

When conducting business research there are two different approaches to use that guides the researcher through the relation between theory and research (Bryman & Bell, 2011). The approaches, deduction and induction, describe what the research is based upon, and what type of conclusion it aims to derive. Babbie (2014) describes deduction as starting with an expected pattern, which is then tested against the observations. In contrast induction starts with the observations, and afterwards seeks to find patterns within them (Babbie, 2014).

The researcher using a deductive approach deduces a hypothesis, based on a set of theories, that later is to be tested towards the empirical findings (Bryman & Bell, 2011). The theories are derived from common sense, observation, or from the existing literature (Bernhard, 2011). Observations based on the hypothesis are then done, which either confirm or falsify the hypothesis (ibid). The hypothesis derived should design the research strategy suitable to test the hypothesis (Saunders et al., 2009). When using a deductive approach, sufficient knowledge of the research area is demanded in order to formulate the hypothesis. Consequently, the researcher is limited to the theory available, and there is a risk of missing new results of recent studies during the investigation of the theoretical framework (Patel & Davidson, 2003). Bryman and Bell (2011) describe the deductive way as a top down approach in order to localize the core data by isolating the remaining data step by step. The cycle is repeated in order to verify the reviewed theory (Robson, 2002). Consequently, deductive research moves from general principles of an expected pattern, to specific expectations of hypotheses (Babbie, 2014). The hypotheses are then tested through observations in order to see if the patterns actually occur (ibid).

In contrast, inductive research moves from specific observations, to more general discoveries of patterns that represent some degree of order among the investigated events (Babbie, 2014). Using this approach the researcher develops new theory constructed from the findings of collected data (Saunders et al., 2009). Inductive reasoning is based on the search of particular observations of patterns and regularities, in order to develop explanations that can become new theory (Bernhard, 2011). The explanations are based on series of hypotheses that are modified and tested on new cases, in order to reach conclusions that generate broader generalizations and theories (ibid). Clearly defined, while the process of an inductive stance begins in the findings and has the outcome of a theory, the deductive process begins with a theory and has the outcome of the findings. (Bryman & Bell, 2007) Consequently, inductive research can be seen as a bottom up
approach (ibid). As the conclusions are based on findings from observations, there is a risk that the prior theoretical investigation is too narrow due to the specific area of interest (Patel & Davidson, 2003).

Generally speaking, an inductive approach is more suitable when little is known about the problem, and observation is there to guide the researcher (Bernhard, 2011). Conversely, a deductive approach is better suitable when more is known about the problem (ibid). However, as observations in the real world seldom, or ever, match the expectations of the researcher, it is important to decide whether the match is close enough in order to confirm the hypothesis (Babbie, 2014). Instead, by using an inductive method, the researcher comes up with a tentative conclusion based on the pattern of the observation (ibid). It is easy to separate the approaches in the theory, but in reality, research is never purely deductive or purely inductive (Bernhard, 2011). Babbie (2014) present a clear model of the relationship between induction and deduction, which he calls “The Wheel of Science”, Figure 5. The model is reprinted and adapted from the original source by Walter Wallace (1971). Babbie (2014, p. 51) explains that ”In actual practise, theory and research interact through a never-ending alternation of deduction and induction”. The real world is more dynamic and unpredictable than the theory can be adjusted to, and there are thin rules of how and when a research should start and finish (Babbie, 2014). According to Bryman and Bell (2011) both the inductive and deductive approaches should be thought of as tendencies instead of strict distinctions.

![The Wheel of Science](Image)

Figure 5. The wheel of Science

Based on the reasoning above, an inductive approach was used for this thesis. The research moves from specific observations, to more general discoveries, which is associated with an inductive approach. In addition, the knowledge of the problem area is limited, indicating an inductive approach. Due to the inelasticity of the research approaches, there has been a dynamic interaction of going back and forth between data and theory during the whole process. First of all, relevant data has been collected based on the specific area of interest. Once we had a substantial quantity of collected data, we had a closer look in each of the categories, and then summarized them all together in order to see patterns that could be fruitful for our study. After analyzing the data in different ways and angles, the statements from the interviews were added. By
interconnecting the data and the statements, observations could be derived from the combination of the two. After theorizing about the patterns we could find, we were able to derive general theories that could explain the patterns of the data.

### 3.2 Research method

When conducting research there are two main methods to use, quantitative and qualitative research (Bryman & Bell, 2011). The aim of both is to generate, process and analyze the information and data that are collected (Patel & Davidson, 2003). The qualitative research is used when the researcher wants to gain understanding of a problem, theory, or other issue (O’Farrell, 2015). It is often described as the opposite to quantitative research as it emphasizes words rather than numbers and quantifiable data collection (Bryman & Bell, 2011). Qualitative research seeks to formulate an explanation of why things are in a certain way, while quantitative research is concerned with objectively measurable variables (O’Farrell, 2015). Stake (1995, p. 54) explains that “Qualitative researchers treat the uniqueness of individual cases and contexts as important to understanding”. Consequently, the qualitative method is more subjective as it is concerned with personal perspectives, feelings, and beliefs (O’Farrell, 2015). Subjectivity is an essential element for understanding in this kind of research, and should not be perceived as less trustworthy (Stake, 1995). Qualitative research is commonly referred to as having an inductive approach, and quantitative research as having a deductive approach (Yin, 2014; Bryman & Bell, 2011). However, inductive and deductive approaches are not isolated from one another (Babbie, 2014), neither are qualitative and quantitative methods (Bryman & Bell, 2011).

This study investigates the very first phase of NPD called the Front End (FE), where firms have little documented data and knowledge of what is happening. The IPPs of the FE are in general hard to document and many firms do not even make distinctions between how their dispersion look in radical and incremental projects. The field of research is relatively new and information should preferably be acquired from people active and knowledgeable in the area. The emphasis on expertise from personal experiences indicates that the method is subjective. Bryman and Bell (2011) says that qualitative research is associated with in-depth learning and understanding. Consequently, based on the lack of data and the need of deeper understanding, a qualitative approach was chosen for this thesis in order to answer the research question. The main steps of qualitative research that are listed by Bryman and Bell (2011) have, with some modification, been used as a guideline throughout the development of this process. Consequently, the research is structured as (1) Scanning of prior research; (2) Formulation of general research question; (3) Selection of relevant theory; (4) Collection of relevant data; (5) Interpretation of data; (6) Conceptual and theoretical work; (7) Tighter specification of research question; (8) Collection of further data; (9) Observation of findings; and (10) Notation of conclusions (Bryman & Bell, 2011, p. 390). Overall, the process can be identified as above, but with an interaction between the steps 5 to 10 the procedure has been more iterative.
The research topic was established through the aim of helping firms to manage their NPD more effectively. The research question was then derived based on the literature review of prior research. Lack of satisfactory information processing has been found as an influencing factor to long and costly NPD processes. We found that IPPs within the FE only are partially researched. After further research, we also found that the problems investigated have been described and named quite differently by most authors. In order to fully understand the meaning of the problems, we had to study each of them more carefully. Some words were used more than others, and some of them were argued to be closely linked to one another and could therefore be assembled. Finally, we could extract three problems that we found the most important, i.e. uncertainty, equivocality and complexity. We decided to study these three IPPs with a focus on the first phase of the NPD, the FE. In order to compare the influence of the three IPPs, we decided to add an additional term. We found that there was limited research concerning how to manage radical and incremental projects in the FE. We suggested that the influence of the IPPs should be different in these two kind of NPD projects, and should therefore probably be differently managed. Based on this suggestion, we started to derive the purpose of the thesis, and to formulate a corresponding research question. In order to measure the IPPs, we decided to use the terms frequency and impact. An argumentation of why these two parameters were chosen is given in Chapter 2.4.4. However, the two measurements are rather negligible one by one, but merged they can add far more valuable information. Consequently, the term significance were added, in order to compare the differences of the perceived importance of the IPPs. Therefore the aim of this study is to investigate the differences of the significance and dispersion of the IPPs, during the FE, when comparing radical and incremental NPD projects.

3.3 Research strategy

There are several strategies to use when conducting business research. Yin (2014) lists surveys, experiments, histories, case studies, and statistic or economic modeling as strategies. Instead of the last two strategies, Saunders et al. (2009) list four more, i.e. action research, grounded theory, ethnography and archival design. Some strategies are better suitable when using a deductive approach, and some when using an inductive approach (ibid). It should be noted that the strategies are not mutually exclusive and can preferably be combined (ibid). Each of them can be used for exploratory, explanatory and descriptive research (ibid). Exploratory research is likely to be connected with an inductive approach, while descriptive research is likely to be connected with a deductive approach (Bernhard, 2011). However, depending on how the research question has been posed, a difference is made between exploratory and explanatory research (Yin, 2014). The research question in exploratory research mainly focuses on questions such as “what” (ibid). These questions are similar to “how many”, or “how much”, and are likely to favor survey methods or any kind of analysis of data (ibid). By contrast, questions posed as “how”, tend to be more explanatory (ibid). These questions are preferably used in case studies, histories, or experiments (ibid). Besides the research question(s), the strategy is also guided by additional factors, i.e. the existing knowledge in the area, the amount of resources and time, and the
philosophical foundation that the research is based upon (Saunders et al., 2009). The research strategy will by the end of the research enable for the researcher to answer the research question(s) (ibid).

### 3.3.1 Case study research

Bryman and Bell (2011) state that when the aim of a research is to reach a deeper understanding of a problem, case studies are the appropriate strategy. For that reason, and based on how the research question is posed, a case study strategy was decided to be used for this study. According to Yin (2014) the strategy is preferred when (1) the main research questions are posed as how or why; (2) when the researcher has little control over behavioral events; and when (3) the study is focused on a contemporary phenomenon that is not historical related. Moreover, should a case study cope with more variables than only data, rely on multiple sources of evidence, and be guided by prior theoretical propositions when collecting and analyzing the data (ibid).

Yin (2014, p. 145) refers the definition of case study research to Robson (2002), as “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. Yin (2014) also refers to his book Case study research from 2003, where he states that the boundaries between what is studied, and its context, are not clearly evident. Surveys do not need a highly controlled context either, but the number of variables limits the ability to explore and understand the context (Saunders et al., 2009).

When conducting case studies, there are several types of designs available that should be considered before starting. According to Yin (2014) the primary distinction of case study design is between single- and multiple-case studies. Multiple-case studies were before considered different from single-case studies, as the research strategies were developed for different rationales (ibid). However, Yin (2014) considers the terms as two variants of case study research, with no broad distinction between them. Multiple-case study is commonly referred to as comparative, which partly explains the meaning of the research design (ibid).

The second distinction of case study design is between holistic and embedded cases, which refer to the unit that is investigated (Yin, 2014). The holistic case study design is an analysis of a single unit (ibid). It is for example a case study of a firm, where only one unit is being analysed. If the research examines multiple units, the case instead is called an embedded case study (Yin, 2014). This could for example be if a number of sub-units within a firm are investigated. The same works for multiple-case studies, where the investigation examines several units within each of the firms involved (Yin, 2014).

As the aim of the thesis is to find differences in radical and incremental projects, a comparative approach is suitable. This entails that a multiple-case study is appropriate and chosen as research strategy for this study. The study is also limited to a specific research area, and should therefore not investigate several sub-units, which indicates that a holistic multiple-case study is used for the research.
In multiple-case study more than one case are included and the focus is to establish if findings from one case can occur in other ones as well (Yin, 2014). Yin (2014) refers to Herriot & Firestone (1983) when stating that multiple-case studies often are regarded as more robust than single-case studies as the research is based not only on one single situation, experiment, or firm. This should not be mixed with having multiple respondents, which for example is the case in surveys that instead follows a sample design (Ibid).

3.3.2 Case selection

A total of seven persons within six firms were interviewed. When selecting the respondents, a discussion arose of whom to interview and what kind of experience that person should possess. In order to secure the quality of the empirical data, an emphasis was put into choosing the best suitable persons for the interviews. As actions and decisions being made during the FE are poorly documented within most firms today, the best suitable persons for interviews were people with extensive knowledge and long-term experience in the business area. All the respondents selected are therefore professionals in NPD, many with a high position within the firm where they currently work. Due to practical reasons, it was also decided that only persons with experiences working in Swedish firms were to be chosen, as there is an abundance of such persons in connection to Halmstad where the study takes place. An additional reason of the limitation was due to the business culture that potentially differ between countries. The structure and management of the FE is most likely more homogenous within the borders of one country. The reason why persons from different firms were chosen was to guarantee that at least some of their prior knowledge was differentiated. By doing so, the data collected and the findings of the study became more generalizable since the research did not focus on any specific business area or a certain type of product. It is true that two of the respondents come from the same Swedish firm. However, they work in two different NPD departments with different responsibilities, and have completely different backgrounds. This guarantee that they possess differentiated knowledge and experience.

As discussed in the theory, Chapter 2, this study will only focus on NPD concerning goods, and not services, since the majority of prior research and literature is connected to it, making it easier to find suitable research to study and compare. In addition, a majority of the persons suitable for being interviewed about technology innovations have more extensive experiences from goods than services. Therefore, we decided to limit the range of respondents to persons with experience in firms that manufacture goods within both radical and incremental projects.

When using a qualitative approach, the number of cases to analyze should be limited in order to be able to fully deepen the understanding of each situation (Bryman & Bell, 2011). The amount of respondents should therefore be limited to be manageable. As the research question is of a comparative nature, a number of four interviews were considered a minimum of respondents. It could be argued that two or even one case study would have been reasonable when making a comparative study between two types of activities. However, as the study contains an element that could be argued to be of quantitative nature (i.e. the questionnaire) – although it represent
qualitative values – one or two case studies was not considered enough. Furthermore, when comparing cases, the research should aim to reach for saturation in the results, meaning that the trend should be clear and no more data is needed. Due to limitations in time and resources, the amount of cases was limited to seven respondents. It could be argued that the amount of respondents are few in proportion to the width of the selected cases (all kind of goods, in all kind of business areas). However, as this study is among the first of its kind, a minor number of case studies should be conducted so as to truly find depth (quality) instead of size (quantity). After such an initial study has been conducted, additional studies could be done, which either incorporate a larger number of case studies, or that narrows the study further.

Overall, when conducting qualitative interviews, the researcher has to be aware of the ability of the respondents to influence the outcome of the research. The opinion of the researcher as well easily affect both the outcome of the interviews and the analysis of the data. In order to completely enroll and clarify the truth of a problem, if ever possible, the saturation level is close to unlimited. Furthermore, in a perfect research, there should not only be one kind of research method, but instead a combination between different methods. In addition, Bryman and Bell (2011) argue that a mixture between qualitative and quantitative research has several strengths. Obviously, the researcher has to constrain the choices of methods in order to acquire any results and complete the research. By narrowing a problem by conducting multiple partial studies, together the findings can become strong. A large and comprehensive research might be too overwhelming and vague, and still acquire additional corresponding research. Important when conducting research is to always be aware of the complications and limitations of the study, and not impose any conclusions too hasty or definitely. This oblige for all kind of research, independent on size, but obviously decreases with the saturation level. The amount of respondents in qualitative interviewing is an important factor when considering the utility of the data. However, a small amount of data is not useless, but needs to be managed more carefully.

3.4 Data collection

There are several methods of collecting data that are suitable when conducting case studies, e.g. interviews, observation, documentary analysis, and questionnaires (Saunders et al., 2009). The techniques are not isolated from one another and can advantageously be combined. The techniques described are all examples of different methods to collect primary data. This is new data that is collected by the researcher. However, there are two different categories of data, where the other one is called secondary data. This is data that have been gathered by other people, such as investigations, experiments and surveys. This data can be found as articles, reports and other documentation that is suitable to use in order to support the findings of the research.

3.4.1 Primary data

Interviews in qualitative research are normally far less structured than interviews used in survey research (Bryman & Bell, 2011). A reason to this is that the qualitative research aims to find deeper understanding of the experiences of the respondent (ibid). Quantitative research, by
contrast, aims to see patterns among a large amount of respondents (ibid). The main point of studying qualitative research is to be able to reach a deeper knowledge of the unique experiences and stories of the respondent (ibid). Semi-structured or unstructured interviews are suitable methods to use when the experience from the respondent is wished (ibid). To be able to see relationships between the different interviews and secure the focus of the subject, one of these less structured methods is required (ibid). When using a structured interview, there is no room for the respondent’s stories or interpretations (ibid).

For the reasons above, semi-structured interviews were chosen to be used for this study in order to gather the empirical data. The semi-structured method allows the respondents to answer both openly out of their own experiences on all questions, but at the same time the organized questions ensure that all themes are touched, the focus of the subject remains the same, and the time frame does not differ dramatically between the interviews (Bryman & Bell, 2011). The method also allows the interviewer to ask sub-questions, and to skip less important ones (ibid). A qualitative interviewer is expected to have prepared a list of issue-oriented questions that are concerned to be the most important for the research, in order to complete the agenda (Stake, 1995). The questions should not aim for simple yes or no answers, as the intention is to achieve an episode, a linkage, and an explanation (ibid).

Before starting each interview, a brief introduction of the research purpose, and the respondent’s role in the research, was explained. In order to avoid misinterpretations, difficult terms and concepts that were used in the interview guide (Appendix 1) were discussed and clarified. We have understood that the terms used in our theory are not always consistent with the terms used in the real world. Permission to record the interview was given by the respondent before its start. As the interviews are based on knowledge from the full working life experience of the respondents, and not only from the specific firm that they work for, we have chosen to keep the firms confidential. The firms were contacted by mail and through relatives and friends.

A pilot interview was also conducted with a person not connected to the University in order to ensure that the questions were understandable. It helped us to further adjust our interview guide into being more comprehensible and straight forward. Bryman and Bell (2011) recommend researchers to conduct pilot interviews in order to detect incomprehensible and inconsistent questions that can be addressed and changed before the real interviews take place. Problems with poor or unclear phrasing can also be detected and improved (ibid). In order to get honest feedback, we think it is an advantage to be acquainted with the pilot respondent. The respondent in our case is a relative that works within NPD of goods, but does not have as extensive experience as the other interviewees. However, Krefting (1991) points out the risk of having a close relationship with the respondents. Such a situation may cause difficulties for the researcher to separate his or her own interpretations from the values of the respondents (ibid). Because of this, none of the other respondents have a close relationship with us.

The interviews were structured in the same way for all respondents, starting with some highly unstructured questions about the background of the respondent, moving on with semi-structured
questions, and ending up in a questionnaire (Appendix 2). The (1) first paragraph of the interview guide provides general information about the respondent’s prior experience: such as education, different positions, and involvements in different projects. (2) Second paragraph deals with questions about the FE. (3) Third paragraph introduce IPPs, and the (4) fourth paragraph directly reflects the research topic as it allocates how the IPPs are linked to radical and incremental NPD. According to Patel and Davison (2003) the funnel technique of asking questions is argued to be activating and motivating, which facilitates for the respondent to formulate and answer to the questions later on. During the initial 13 questions, the respondent was asked to elaborate his or her answers based upon examples and experiences from prior projects. Throughout the interview, we helped the respondent to build scenarios and connect them to our research. This is recommended by Patel and Davidson (2003) in order to maintain a coherent reasoning through all questions. During question 14 to 17 (the questionnaire), the respondent was asked to elaborate the ratings with examples and explanations. As the questionnaire mirrors the discussion throughout the whole interview, it provides a distinct reflection. The questionnaire is therefore not meant to be a full worthy analysis by its own, but together with examples it provides a clear and comprehensible summary of the empirical data. For each construct of the questionnaire, we used a one-item scale that ranged between 1 and 10. In order to observe any differences of IPPs in radical and incremental NPD, the two variables frequency and impact were added to serve as a measurement. The informant was then asked to rate the impact and frequency of IPPs in radical and incremental projects within the FE. The questionnaire provided a good compliment to the open-ended questions. It did not only provide a more precise understanding, but as well a clearer picture of the whole interpretation of each interview.

A total of seven semi-structured interviews were conducted at six different firms. Three of the interviews were conducted on site, and four of over telephone. Due to the distance and limitation in time for both us and the respondents, telephone interviews were regarded as an “acceptable” method. The questionnaire was sent out in beforehand so that the respondent could more easily follow our questioning during the telephone interviews. We are well aware of that face-to-face interviews are preferred when conducting in-depth research as the behavior of the respondents might influence the conversation. However, when it comes to the answers, there is little difference between the methods. The topic is not sensitive, and according to Saunders et al. (2009) telephone interviews represent a valid alternative in case of limited resources or geographical distance.

The lengths of the interviews varied from 34 minutes to 1 hour and 28 minutes. All interviews were recorded and transcribed. The face-to-face interviews were conducted at the firm site of the respondent, two of them in a conference room, and the last one in the office of the respondent. We are aware of that the location of where the interview takes place might affect the response from the respondent. As previously stated, our research topic is argued to not be sensitive; why we let our respondents choose the location for the interviews. However, we experienced a strong fondness to the firm of each respondent, which we think would have been less dominant if the
interview took place at a different location. All the interviews presented are confidential, meaning that the cases are all known by us, but named after a Greek letter in this study in order to keep them anonymous to the reader (Patel & Davidson, 2003).

Table 1. Date and duration of the interviews

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Interview type</th>
<th>Date</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>Telephone</td>
<td>Thursday, 26th of February, 2015</td>
<td>36 min</td>
</tr>
<tr>
<td>Beta</td>
<td>On site</td>
<td>Monday, 23rd of February, 2015</td>
<td>43 min</td>
</tr>
<tr>
<td>Gamma</td>
<td>Telephone</td>
<td>Tuesday, 14th of April, 2015</td>
<td>58 min</td>
</tr>
<tr>
<td>Delta</td>
<td>Telephone</td>
<td>Friday, 17th of April, 2015</td>
<td>53 min</td>
</tr>
<tr>
<td>Epsilon</td>
<td>Telephone</td>
<td>Friday, 17th of April, 2015</td>
<td>34 min</td>
</tr>
<tr>
<td>Zeta</td>
<td>On site</td>
<td>Thursday, 16th of April, 2015</td>
<td>88 min</td>
</tr>
<tr>
<td>Eta</td>
<td>On site</td>
<td>Friday, 24th of April, 2015</td>
<td>62 min</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>6h, 15 min</strong></td>
</tr>
</tbody>
</table>

3.4.2 Secondary data

Before the research question was designed, relevant literature was browsed in order to create an idea of prior research. Our supervisor supported us with articles in the area as he has good knowledge of the topic. The area of investigation was relatively clear from the start and we could rather quickly begin the screening process. Saunders et al. (2009) recommends the researcher to examine lecture notes and course literature in order to obtain interesting ideas of topics and relevant authors. When deciding what angle we wanted our research to be, we reviewed our notes and course literature, but did in the end not focus in any of these areas. The online library of Halmstad University provided many articles in academic and professional journals, which was a useful searching tool in the screening process. Other databases such as Google Scholar, IEEE and Web of Science were also used. To ensure a credible content, the search results were in the beginning limited to peer reviewed articles. According to Wager, Godlee and Jefferson (2005) using peer reviewed articles guarantees a higher quality than normal articles. This is because the peer reviewed articles already have undergone scrutiny from knowledgeable researchers in that field (Wager et al., 2005).

Some of the keywords used in the search for secondary data were uncertainty, equivocality, complexity, Front End of new product development, Front End of Innovation, new product development, knowledge problems etcetera. Once an article was found, new keywords were used, including the articles’ references or other pieces by the author. When searching for theory, there was a lot of information about knowledge, what it is and its definition. The term can be discussed and rephrased many times and in many different ways, depending on the aim for its use. We decided to give a comprehensive description of the definition for our study, so that
misunderstandings and misinterpretations could be avoided. However, it was not hard to differ between useable articles and those with a philosophic content. For the theory, mainly articles from academic and professional journals have been used. The area is relatively new, and there are few books written. Overall, books tend to be less up to date than articles and other journals, but as many articles do, they still persist. Theory about research strategy and methodology are less narrow, and provide large quantities of information. There are many books written about these subjects, why the main source comes from these.

3.5 Data analysis

When conducting qualitative interviews, the respondent is allowed to describe a phenomenon with his or her own words (Patel & Davidson, 2003). In order to generate fundamental findings, an analysis should consist of examining, categorizing, testing, or recombining evidence (Yin, 2014). The main point when analyzing the data is to find patterns, understandings, or promising theories (ibid). The analysis is made through four steps, (1) Analysis of data and establishment of an idea of the overall results; (2) Observation of similarities and differences between statements in the interviews; (3) Categorizing of statements and perceptions into different categories; and (4) Analysis of the underlying structure of the categories (ibid). The method indicates an inductive approach as the researcher sort the empirical data until patterns are viable (ibid). The categories of patterns cannot overlap, and should be different from one another (ibid). As perceptions of the human change with new knowledge and experience, the so-called phenomenographic qualitative research does not aim to find conclusive theories (ibid).

The empirical data gathered through the case studies, together with the theories from the literature review, provide the base on which the analysis was made. As previously described, a holistic multiple-case study was designed to be used for this research. Analyzing case studies is a difficult thing to do, as how to analyze the evidence, is only slightly developed. Therefore Yin (2014) purposes four general strategies to analyze the data, i.e. relying on theoretical propositions, working your data from the ground up, developing case descriptions, and examining rival explanations. For this thesis, the first analyzing strategy was used. The strategy is based in the theories, which was the fundamental reason of conducting case study research. The research question was derived through the literature review, which established the research design and consequently resulted in a case study analysis based on the theoretical propositions. Consequently, the collection and analysis of data have been designed and organized by the theories extracted from the literature review. The data from the questionnaires were elaborated and analyzed through different kind of diagrams, and divided into subcategories in order to observe patterns. In the analysis, the questionnaires were presented in charts, showing the frequency and impact in radical versus incremental projects. The questionnaires and interview recordings were analyzed together in order to follow the argumentation. A short background of each respondent is added in order to give him or her additional trustworthiness. After individual data has been presented, summarizing charts are presented in order to provide a picture more easily grasped. During the process, there has been a frequent back and forth between the theories.
and the data collected. The prior knowledge of the researchers have helped the analysis of the collected data, however, the own interpretations have as far as possible been isolated from the research, in order to achieve objective results.

### 3.6 Judging criteria

When conducting research, several judging criteria should be applied throughout the whole process of the investigation in order to ensure a good quality (Yin, 2014). There are three prominent evaluation criteria to use when conducting business and management research, i.e. reliability, validity and objectivity (Bryman & Bell, 2011). These terms are mostly connected to quantitative research, as they are concerned with the adequacy of measures (ibid). Therefore there are authors that suggest other terms that are better suitable for qualitative research (ibid). Bryman and Bell (2011) list the four criteria by Lincoln and Guba (1985) as alternative terms to trustworthiness, i.e. credibility, transferability, dependability, and confirmability (ibid). All the four criteria have a parallel with the previously mentioned criteria of quantitative research (ibid). However, in the book Case Study Research, Yin (2014) has listed four other criteria that are better suited for case studies. The advantage of these new criteria is that several tactics are listed for each of them (ibid). These four criteria are also connected to the above mentioned ones, and are named construct validity, internal validity, external validity, and reliability (ibid). Various terms have been used as judgement criteria in research evaluation. In this thesis, the criteria by Lincoln and Guba (1985) is used due to the reason that it has been used by many researchers before, and can therefore be considered as a reliable judgement. Nevertheless, general statements of trustworthiness are in addition described throughout the methodological approach. In Table 2 the criteria previously revealed and the connections between them, are listed.

**Table 2. Comparison of judging criteria**

<table>
<thead>
<tr>
<th>Case study method</th>
<th>Qualitative approach</th>
<th>Quantitative approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal validity</td>
<td>Credibility</td>
<td>Internal validity</td>
</tr>
<tr>
<td>External validity</td>
<td>Transferability</td>
<td>External validity</td>
</tr>
<tr>
<td>Reliability</td>
<td>Dependability</td>
<td>Reliability</td>
</tr>
<tr>
<td>-</td>
<td>Confirmability</td>
<td>Objectivity</td>
</tr>
<tr>
<td>Construct validity</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

When conducting research, evaluating criteria are important to use. However, one should know that applying the same standard is not appropriate for all kind of qualitative research (Krefting, 1991). As long as a researcher clarifies what methodological procedure that is used, it matters less if it is in terms of validity and reliability, elaborated throughout the methodological approach, or in terms such as the four described (Powers & Knapp, 2010).
3.6.1 Credibility

Credibility parallels to internal validity, and refers to how believable the findings are (Bryman & Bell, 2011). In the criteria by Lincoln and Guba (1985), it is the most important key to trustworthiness (ibid). Powers and Knapp (2010) suggest six criteria to establish credibility: (1) Accuracy of the discoveries; (2) Negative case analysis, e.g. exceptions; (3) Relevance of data; (4) Adequacy of data; (5) Verification by use of data sources; and (6) Consultation with colleagues.

(1) When conducting interviews, there is a risk that the researcher influences the conversation. In order to obtain unbiased responses, most questions were open-ended.

(2) Negative cases are those that differ from the assumptions and expectations. When analyzing the cases of this research, all were not consistent with one another. Some results normally differ from the rest, and it is therefore important to not make rushed conclusions in such a small sample of cases like this. However, the findings should be elaborated both together with the remaining data, and as well individual. Negative cases can be an important finding when strengthens results from other cases. A third conclusion was found when analyzing irregular data.

(3) The respondents chosen are all professionals and experienced in NPD. Obviously, the selection will affect the outcome of the research in the sense that a conclusion based on a specific type of business area cannot be made. However, we argue the research to be necessary and helpful for firms when structuring the FE, as IPPs in radical and incremental projects are not a widely spread concept. Retrospectively, the selection of respondents was too diverse in the sense of varying experience of business areas. More accurate conclusions could have been made if the sample were more homogeneous. However, as the study is not limited to a certain business area and the case selection require less accuracy, the study is given a wider perspective through the dispersion of firms. This makes the results more generalizable and do not only refer to a specific business area. The interviews provided appropriate data that were analyzed together with the questionnaires. All the respondents participating in the interviews were engaged in answering the questions and showed interest in the research. Throughout the study, different scenarios are also exemplified and discussed in order to provide a good picture of the problem.

(4) The quality of a research can be measured through its relevance and adequacy. This means that it should contain sufficient amount of data (e.g. saturation) in order to explain the purpose of the research. When conducting case studies, it might be possible to achieve saturation after 30 to 40 case studies. However, we can confirm that we already after 2 to 4 interviews had a good impression of the IPPs. Nevertheless, the amount of case studies used
in this study could be argued as too few, but were limited to seven due to limitations in time and resources.

(5) The questionnaire in our research can be argued as a technique of triangulation as it determines whether the interpretation of the interview is correctly understood. The emphasis of triangulation concerns the use of more than one method or source of data (Bryman & Bell, 2011). Using several methods for this study were argued to be too time consuming for the limited time available.

(6) In order to secure meaningful and rewarding interviews, we let our supervisor evaluate our interview guide. It was discussed and then adjusted with some small corrections. A pilot interview was also conducted with a person that is not connected to Halmstad University. The respondent works within NPD of goods, but does not have as extensive experiences as the other respondents. It is therefore important to consider if unclear questions depend on the limited experience of the respondent, or if the questions would be wrong interpreted by the “real” respondents as well. When designing the interview guide, Bryman and Bell (2011) recommend the researcher to use questions that prior researcher have used. It is argued that by using other researchers’ questions, they are perceived as already piloted (ibid). By applying questions made by others, the measurement quality can be observed as reliable and valid for the research (ibid). The questions can also provide ideas of how to best approach your own questions (ibid). In accordance to the recommendations by Bryman and Bell (2011), our interview guide is inspired by other researchers. In order to answer the research question of our study, the interview guide had to be constructed differently from what others have done, but partly, it has still been inspired. During the spring of 2015, the thesis was reviewed by the supervisor, examiner and colleagues at five different seminars. The critics were constructive and gave us fresh perspectives that were helpful in order to reduce contradictions and clarify ambiguities.

Yin (2014) argues internal validity to be appropriate for explanatory or casual studies, but not suitable for exploratory or descriptive studies. Yin (2014) explains that the criterion assume a study to be conclusive. Therefore it is easy to undertake the wrong relationships when conducting research, and that the study will fail if the conclusions are incorrect. Therefore, this investigation is based upon prior research and with no exceptional assumptions due to the inductive approach.

3.6.2 Transferability

Transferability parallels to external validity, and refers to whether the discoveries are applicable to other situations, or only for the research made (Bryman & Bell, 2011). Powers and Knapp (2010) add that the research should provide enough information for the reader to decide oneself if the findings are applicable to similar situations (Powers & Knapp, 2010). According to Yin (2014) the external validity also refers to that the discoveries should be generalizable despite the research strategy. When analyzing the results from case studies, analytic generalizations should
be performed (Yin, 2014). Yin (2014) defines *analytic generalizations* as to generalize findings or to learn lessons by identifying theoretical concepts. When conducting qualitative research it is argued that the scope of findings is too limited to be generalized to other situations (Bryman & Bell, 2011). Yin (2014) describes the concept as *statistical generalizations*, which is being used when a sample can be derived from a larger population. Bryman and Bell (2011) confirm that a small number of people that are being interviewed in a qualitative research obviously cannot be representative to a whole population, but however, they are not meant to. In qualitative research the findings are not designed to be generalizable to populations, but rather to theory (Bryman & Bell, 2011). It is the quality of the theoretical implications that is the vital strength when considering the generalizability of the findings in qualitative research (ibid).

The analytic generalization of this study was derived through the theoretical concepts that the research is built upon, and then elaborated together with the findings of the case studies. The wide range of cases includes several industries, which indicates that the findings are not limited to a certain business area. In order to gain further transferability to the study, people from a more homogeneous scope of companies could have been interviewed. However, the aim of the study is to provide an overview of the influences of the IPPs in radical respective incremental projects. A more homogeneous scope would require an investigation of one or a few kind of industries, which would limit the conclusion to be valid only for these industries. The study might not be strong enough to draw certain conclusion of specific facts, but summarized the conclusions can be generalized in order to provide new information to the research area. The findings represent a range of industries within NPD of goods, and prove the importance of managing the IPPs well in all firms within the business area. The conclusions can therefore be applicable to many industries, but with restraint due to the partial coverage of industries.

The seven interviews are conducted with a good range of professionals, with long and qualified experience. However, interviews are based on the interpretations of human beings, and might not be the perfect source of evidence. Qualitative research has been criticized for being too subjective as the findings is highly dependent and influenced by personal views and interpretations of the researcher (Bryman & Bell, 2011). The information then change over time, and differ from person to person within the same industry (ibid). Because of the unstructured nature of qualitative data and the risks of the respondents being influenced by the subjective learning’s of the researcher, it is difficult to replicate qualitative findings (ibid). However, the findings can be observed as average generalizations, and not definitive conclusions due to the relatively wide sample selection.

### 3.6.3 Dependability

Dependability parallels to reliability, and refers to whether the findings are likely to apply at other times (Bryman & Bell, 2011). The criterion is established through a well-documented research process that provides the reader with information of how the findings have been conducted, and whether similar results can be acquired by other researchers (Powers & Knapp,
2010). Important to note is that the same study should be possible to do again, and not only conducting a replication using the same results in another case (Yin, 2014).

The process of the research is carefully described in the methodological approach. Although, as explained in previous paragraphs, results from the interviews are dependent on the experience and personality of the respondents. The ratings of each respondent varied, but the argumentations were in many subjects similar, and only differed due to the business area. If interviews were conducted with persons within similar firms, we assume the findings to be similar in a general conclusion.

During the elaboration of this thesis, we used an online document that both of us had access to. There we wrote important dates for interviews etcetera, new thoughts and ideas that were important to not forget, and what was left to do in order to complete the thesis. A Gant-chart was used in order to check if the progress was in line with our estimations. In case of any delays, the chart was improved to maintain a consistent guideline. All the interviews have been recorded and noted, listened to, and partly transcribed.

3.6.4 Confirmability

Confirmability parallels to objectivity, and refers to what extent the study is influenced by the values of the researcher (Bryman & Bell, 2011). Confirmability is established through well-grounded documentation of the links between data and the researcher that can ensure a credible, clear and complete result, without any interpretation from other sources than the collected data (Powers & Knapp, 2010). The methodological approach should as well be reasonable for the procedure of the research (ibid).

Before starting each interview, a brief introduction of the research purpose and the role of the respondent in our research, was given. We have also understood that the terms used in our theory are not always consistent with the terms used in the real world; therefore difficult terms and concepts in the interview guide were cleared out in order to avoid misinterpretations. After completion of the questionnaire, each rating was discussed with the respondent in case any of the answers had changed during the questionnaire. Throughout the completion of the questionnaire the respondents were also asked to elaborate the answers with explanations and examples, in order for us to follow the argumentation and to notice if the answers were consistent with the descriptions we had been given of the IPPs. Many quotations by the respondents are presented in the research in order to increase the confirmability. By using quotations, it is easy for the reader to separate interpretations of the researchers, and the statements of the respondents. Obviously, it is more or less impossible to completely isolate the own interpretations in qualitative research. However, confirmability can be obtained through open-ended interviews, as previously stated, in order to maintain biased answers.
3.7 Ethical considerations

In this study, the respondents are kept confidential as we saw no value of addressing them by name, instead of their real names they are given code names. By keeping the respondents confidential we let no room for the reader to make their own conclusions and interpretations based on gender, ethicality or cultural differences. These factors may contribute to differences in the results in one way or the other, but does not provide information that is needed for the investigation. In order to make generalizations between sexes, cultural differences etcetera, a far larger amount of respondents are required. This kind of specific research will be advised for further research.

3.8 Final remark

Bryman and Bell (2011) argue that qualitative research often lack transparency of how the research have been conducted. In quantitative research the methodology is clearer as the reader easily can follow how the data have been used (ibid). In this thesis, an attempt to clearly outline how the data have been conducted and analysed has therefore been made.

It is likely when using an inductive approach, that the design of the research question has to be redefined, or that the frame of the scope has to be narrowed (Saunders et al., 2009). This is because of the loosely defined nature of the explanation, which is not derived through existing theory, but from case studies that are selected purposively in order for the problem to be explored (ibid). As prior theory was carefully reviewed before the research, we have argued the intake of the problem to be of a deductive approach. Patel and Davidson (2003) describe how the selection of cases should be made. They state that when time and resources are limited, an accessible sample group is required, i.e. either a sample or a limited case (ibid). In researches like this, a statement cannot be proven for other situations that reminds of the investigated one (ibid). However, an estimation of the generalizability of the results can be made (ibid). As the time of this thesis is limited, there is no room for further investigations within the boarder of this course. Consequently, the findings should be perceived as a pre-study for further studies in the area.

3.9 Summary

This study has been conducted by using a qualitative method in order to see if the significance of IPPs vary in radical and incremental projects during the FE. The data collection has been carried out through multiple-case studies using semi-structured interviews. The respondents selected possess extensive knowledge and experience within NPD of goods in Swedish firms. The advantage of this study will be to provide new knowledge to firms in order for them to manage their FE in NPD better, by shortened lead-times and reduced waste of effort and money.
4 Results and analysis

The methodological design of the study gave guiding to how empirical data were to be collected. In this chapter, data from the multiple-case studies will be presented. The collected data were analyzed and are presented in text and figures. The data from the seven interviews will be analyzed both separately and combined, providing results that later are discussed.

4.1 Empirical setting and conditions

For this study, a total of seven interviews were conducted. The respondents were diversified in terms of their capabilities, prior knowledge, and area of expertise. As described in the Methodology, Chapter 3, the common denominator of these respondents is to have extensive experience working with NPD and FE, within goods manufacturing firms in Sweden. The respondents’ identities are confidential and have therefore been assigned code names from the Greek alphabet. A short introduction of each respondent will be given as to show their relevance to this study and to justify the trustworthiness of the primary data they supply.

During the interviews, the respondents were asked to rate their perceived impression of how often, and to what extent the IPPs occur during the FE (i.e. the frequency and impact of the IPPs). The respondents rated uncertainty, equivocality, and complexity separately, both in regards to radical and incremental projects. The result of this rating is presented under each respondent’s descriptive sub-chapter. It is important to note that IPPs are nothing that firms normally document or keep logs of, so the values displayed are therefore only the perceived amount from the respondent’s point of view. Therefore it becomes particularly crucial that the respondents have suitable knowledge and experience.

4.1.1 Alpha

Person Alpha has extensive experience of working with NPD and R&D from several different Swedish firms. Some former positions have included titles such as Technology manager, Product development manager, and Development engineer. The firms are all differed in terms of size and the business area they are active in. Alpha has experience working in NPD projects in the food industry, high tech electronics industry, as well as in several different goods manufacturing firms.

In Figure 6, Alpha’s result from the interview is summarized. The rated values are directly taken from the questionnaire (Appendix 2) that was supplied during the interview. The Y-axis of the graphs displays the perceived importance (X-axis) of each IPP, separately. On the frequency graph, a ten represents “very often” and a one represents “very seldom”. Respectively, a ten on the impact graph represents “very large” while a one represents “very small”.

Alpha has rated uncertainty as the most frequent occurring IPP in radical projects, as well as the IPP with the greatest impact to the NPD process. However, Alpha does also rate uncertainty to represent the least problematic IPP in incremental projects.
4.1.2 Beta

Person Beta has 25-30 years of experience working with NPD at different Swedish firms. Beta’s area of expertise is development of goods connected to composite manufacturing and mechanical engineering. In addition, Beta had a position as an industry-employed doctoral student while continuing studying after a master’s degree in technical chemistry at Chalmers University, Gothenburg. At present, Beta is employed as Director of the R&D department at a Swedish manufacturing firm.

According to Beta, equivocality is the IPP that causes the greatest negative impact in incremental projects, while in radical projects it is rated far lower. Uncertainty and complexity are rated similar; both are considered as frequently occurring and with having a large impact on radical projects.
4.1.3 Gamma

Gamma is a former entrepreneur who managed the NPD process of that firm. The last five years Gamma has been employed by a Swedish consultant firm, working with R&D and product design. At present, Gamma works exclusively within the FE with researching and conceptualizing suggestions that later is to be presented to the firm’s customers.

Gamma considers all the three IPPs as highly relevant to the project’s progress. Uncertainty is considered to be the most frequently occurring IPP in radical NPD, while equivocality is considered to have the biggest impact on the project.

![Gamma - Frequency of IPPs in the FE](chart1)
![Gamma - Impact of IPPs in the FE](chart2)

Figure 8. Frequency and impact of IPPs, Gamma

4.1.4 Delta

During the last decade, Delta has been working as a manager for different activities in the NPD process. All positions were held in Swedish firms, which all are involved in goods manufacturing or goods design. Delta’s major experience comes from employments connected to mechanical engineering in different aspects. Today Delta works as a senior project engineer at a consultants firm who design and conceptualize product ideas given by the customer.

Delta has rated uncertainty and equivocality as the most frequently occurring IPPs in radical projects, where uncertainty also is considered as having the greatest impact to the progress of radical projects. In incremental projects, the frequency of all the three IPPs are rated relatively low, while the impact of them is argued to be relatively high and equal to one another.
4.1.5 Epsilon

Epsilon has been working with R&D related projects for the last 20 years. Manufacturing technician, project leader, and manager of the NPD project leaders are but a few of the positions Epsilon has held during that time. Today Epsilon is responsible for both the radical and the incremental project divisions, focusing on the screening and conceptualizing phase of the FE.

Epsilon has, similar to Delta, rated all the three IPPs high in both frequency and impact in radical projects. In incremental projects, all the IPPs are rated relatively low for both frequency and impact, although complexity is argued to occur rather often relatively the others. Equivocality is rated the lowest in both frequency and impact.

4.1.6 Zeta

Zeta has a master in engineering from Chalmers University, Gothenburg. Zeta has extensive experience in R&D and is currently focusing on the quality management of it. Today Zeta is working as a Master Black belt manager trying to improve the overall quality of the NPD
process. At present Zeta is working for one of Sweden’s largest car manufactures. The majority of Zeta’s experiences come from working with large and complex products.

Zeta has rated the impact of all the three IPPs much higher than the frequency. According to Zeta, the greatest impact is caused by complexity in both radical and incremental projects. Complexity is also regarded as the most frequently occurring IPP in radical projects, while it is regarded the lowest in incremental projects.

![Figure 11. Frequency and impact of IPPs, Zeta.](image)

4.1.7 Eta

Eta has been working with R&D and NPD related tasks for the last 25 years in two different Swedish firms. Eta has an education from Halmstad University, as a computer systems engineer. At present, Eta is working as a Chief technology officer at a Swedish firm who specializes in high tech manufacturing of products containing both hardware and software. Eta has been in business with the current employer since the start-up of the firm, and has been responsible for designing, establishing, and developing the NPD process and its structure.

According to Eta, uncertainty has both the greatest and is the most frequently occurring one. Equivocality is rated equally frequent occurring in both radical and incremental projects. According to Eta, the impact of complexity is argued to be the lowest in both radical and incremental projects.
4.2 Aggregated result

The first step of the data analysis was to make it more accessible and clear. The individual result from each interview will therefore be summarized and aggregated with the others. An average value for each rating category was made. By studying the average numbers of both frequency and impact of the IPPs, further analysis can be made in order to derive the significance of each IPP in the FE.

Once needed, the following equation was used for averaging data:

$$\text{Average (X) of IPPs} = \frac{\text{Alpha(X)} + \text{Beta(X)} + \text{Gamma(X)} + \text{Delta(X)} + \text{Epsilon(X)} + \text{Zeta(X)} + \text{Eta(X)}}{\text{Total amount of interviewees}}$$

**Example:**

$$\text{Average frequency of equivocality in incremental NPD} = \frac{4 + 7 + 5 + 5 + 1 + 4 + 6}{7} = 4.6$$

Equation 1. Averaging of IPP values.

4.2.1 Frequency

Figure 13 summarizes all the data connected to frequency previously presented in this chapter. The color combination of the value stacks corresponds to the previous graphs of each respondent. The graph below is relevant to introduce as the visual sight support when comparing the data. It can be seen in the figure that the dispersion of the respondents’ ratings are slightly diversified.
In order to see the extent of the difference between radical and incremental NPD, the data needs to be analyzed and processed one step further. Figure 14 displays the final outcome of the frequency data analysis. It shows the average frequency for all IPPs (from Figure 13) for both types of NPD. When observing Figure 14, it is clear that all the IPPs have a higher frequency in radical NPD than in any of the incremental ones. In other words, during the FE, the IPPs have far greater significance in radical projects than in incremental ones. Interestingly uncertainty represents the most frequent occurring IPP in radical projects, while at the same time is the least occurring IPP in incremental ones (sharing the lowest score with complexity). Instead, for incremental projects, equivocality is the IPP that has the highest frequency, while at the same time representing the least occurring IPP in radical projects.
Figure 14. Average rating values of frequency in the FE.

4.2.2 Impact

Just as frequency were analyzed and averaged, so too were the impact data. Figure 15 summarizes the data of Impact presented earlier in this chapter.

Figure 15. Dispersion of impact ratings in the FE.
The results presented in Figure 15 show a diversified account of ratings in order to make sense of the data, the average values are presented in Figure 16. Just as in the case of frequency, uncertainty is the number one most rated IPP in radical projects. However, it does not represent the lowest rated one in incremental projects. That position instead goes to complexity.

![Figure 16. Average impact ratings in the FE.](image)

### 4.3 Combining the data

At this stage of the analysis, both the topics of frequency and impact of IPPs have been addressed. However, the purpose and research question of this study is aiming of finding a difference in *significance*, not frequency or impact alone. In order to find the significance of the IPPs, the data needed to be balanced in some manner. By multiplying a respondent’s ratings of frequency with the corresponding impact, the significance of that IPP were derived. A high number represents a high or large significance. For example, from previous graphs it can be identified that Delta rated complexity in radical NPD as having a frequency index of 8. The corresponding impact of complexity in radical NPD was rated as a 9. The significance therefore becomes $8 \times 9 = 72$. By applying the same method to all the other ratings, Figure 17 was created.
Once more, the ratings from each person have been averaged and are presented in Figure 18. This final step of the data analysis shows the average index values of the significance for each IPP of the FE. That IPP with the highest significance in radical projects is held by uncertainty and by equivocality in incremental ones.
5 Discussion

In this chapter discussions are held about the results from the data analysis. The results of the data analysis cannot be accepted right away but instead needs to be questioned, debated, and reviewed. Thoughts, line of arguments, and points made connected to the topic are presented in this chapter.

5.1 Significance levels of the IPPs in the FE

From the Results and analysis-chapter it became apparent that uncertainty, equivocality, and complexity indeed had their differences in terms of frequency and impact. Those differences inevitable lead to that the significance levels of each IPP varied depending if the project were of a radical or incremental nature. The differences in significance levels indicate that the different IPPs are more or less crucial for firm’s to address. Which IPP that should be addressed first depends on what kind of NPD that currently is in progress. As Epsilon (17-04-2015) puts it, “…depending on how we perceive the nature of the project, we focus on different areas so as to proactively prevent problems”, meaning that the firm approaches different kind of NPD projects differently. As the IPPs significance vary in radical and incremental projects, each IPP must be discussed separately in order to understand why they differ.

5.1.1 Uncertainty

Uncertainty represents the IPP that has received the most attention during prior research in the field of NPD (Galbraith, 1973). This fact seems to be mirrored by the data collection as the majority of the respondents responded with clear approval when asked if they were familiar with the concept of uncertainty. For example, Beta (23-02-2015) says that “Uncertainty have been rather popular for firms to study during the last decades. I have at many occasions been involved in programs with the sole purpose of reducing uncertainty”. The same cannot be said about the respondents’ answers concerning their familiarity in regards to equivocality and complexity, where most did not recognize the designation per say, but understood the concept it represented. Eta (24-04-2015) puts it into words “I’m familiar with uncertainty, I think most people are, but we do not work with equivocality and complexity per se, but I understand the concepts now that you have explained it”. This familiarity towards uncertainty could be one of the explanations as to why uncertainty was rated relatively high for radical projects. The notion that one’s familiarity to a subject could influence the outcome of the ratings would indicate that the case study interviews were poorly designed as the respondent did not fully grasp the meaning of the IPPs. However, when looking at the significance level of uncertainty in incremental projects, it is relatively low, meaning that even if the respondent were more familiar with uncertainty than other IPPs, it was perceived as relatively less significant. This would indicate that the respondent indeed grasped the implications of each IPP as the less familiar concepts of equivocality and complexity were rated similar to, or higher than, uncertainty.
Every single respondent was agreeing that uncertainty was more significant in radical NPD than in incremental ones. Alpha (26-02-2015) stated that “I cannot think of a single situation in radical FE where uncertainty is not present. Every time I make a decision, argue, or just simply converse on any topic, there is always a certain degree of uncertainty”. When asked if the same line of though could be applied onto incremental projects, Alpha (26-02-2015) answered: “No, in the incremental FE, to my experience at least, there is often only one item or aspect of the product that is being improved, which naturally represents the uncertainty in that case. All other parts of the product are normally the same as before and therefore not new for me”. Alpha’s reasoning correlates back to the definitions of radical and incremental products; radical products represent a greater level of novelty for the firm than incremental does (Garcia & Calantone, 2001). The more uncertainty there is, the more knowledge is needed to reduce it. When looking back to the definition of uncertainty it says that “Uncertainty represents the gap in information (or knowledge in this case) of what one has, and what one needs to complete a task” (Galbraith, 1973). We can per definition say that the FE of radical NPD, thanks to Alpha’s statement, indeed possess a higher level of uncertainty than incremental NPD does. In other words, the fact that uncertainty was far more significant in radical projects is a direct result of the higher level of perceived novelty of the project. The same argument could be used to explain why uncertainty is low in incremental projects. It is low because there are few novel aspects of the product and a small amount of new knowledge is needed. The results can be seen in Figure 19.

In sum, the degree of uncertainty in a project is directly connected to the level of novelty experienced by the firm. This is why uncertainty in radical projects was rated as having a much higher significance than incremental ones.

### 5.1.2 Equivocality

Equivocality, which represents the issue of multiple interpretations of the same specific item (Daft & Macintosh, 1981; Chang et al., 2007), often leads to confusion, disagreements, and a lack of understanding for the situation (Daft et al., 1987). In the results of the data analysis, presented in Figure 20, equivocality interestingly represents both the least and the most significant IPP, for radical and incremental projects respectively.

During discussions with the respondents, two strong arguments concerning equivocality came up. Firstly, in the FE of radical projects the IPPs became relevant because several aspects of the product were completely new for the firm. According to Delta and Gamma, who have experiences of working as NPD consultants, there are often misinterpretations of information leading to misconceptions (equivocality) between persons, departments, or firms in the FE of
radical projects. Gamma (14-04-2015) puts it like this: “When things are new there is often a period of time in the beginning of a project when a lot of misinterpretations are made”. The point Gamma makes is that equivocality often becomes relevant because things are new and these new things need time in order to sink in and become praxis. The second strong argument that arose during the interviews was connected to equivocality in incremental projects. The argument was the exact opposite of the first one: that equivocality was high when things were not new. At first, the arguments seem to contradict each other, but the explanation was surprisingly simple. Beta (23-02-2015) explains it like this: “More than I care to admit I take things for granted in incremental projects. I mean, as there are few things that are new in that kind of projects, and you have done them before, so you just expect things to work the same way the second time around”. It would seem that firms tend to overlook some safety measures (e.g. explaining extra carefully what you really meant) because they feel too comfortable or confident in incremental projects. Due to this phenomenon, two out of seven respondents actually considered equivocality to having a higher significance in incremental projects than in radical ones.

Literature suggests that communication is one way of reducing equivocality as misinterpretations made needs to be discussed in order to be resolved (Weick, 1969). During the interview with Gamma the importance of regular communication among the project members and stakeholders became even more apparent. Gamma (14-04-2015) reflects “While working as a consultant I believe misinterpretations is one of the biggest problems as we do not talk to the project group very often”. Gamma (14-04-2015) goes on and explains why that is: “Our project group is spread out and consists of people from the customer, the supplier, and the consulting firm.” In other words, Gamma suggests that the regularity of, and time span in between, communication directly affects the level of equivocality in the FE. For example, a misinterpretation of a piece of information that is made during a project meeting might be the most common situation where an equivocal situation arises according to Delta (17-04-2015). The example could be like this: Two of the project members leave the conference room with different ideas of what is to be done or developed. An equivocal situation has occurred. Until the misconception is resolved, the two members will unknowingly work in separate directions of each other. Now, let us assume that the two project members are coworkers, working desk by desk. The chances of the misconception being resolved are high in this case, as they probably communicate several times per day. In contrast, in a situation where the two project members represent the supplier and the customer respectively, they probably will talk less often than in previous case. In this situation, the misconception could exist for a much longer time and causing more waste of efforts, time, or capital. This waste of resources translates to a greater impact of the equivocal issue as the misconception survives
for a longer period of time. In addition, as previously explained, small actions in the FE can have large repercussion later on, which means that equivocal situations needs to be eliminated as fast as possible (Bacon et al., 1994). The point of this reasoning, and the conclusion drawn, is that the frequency of communication directly correlates to the impact of equivocality. In other words, the more often two parties communicate; the bigger are the chances of detecting and resolving the misconception, leading to a smaller impact of equivocality. This conclusion is not restricted to apply only to radical or only incremental projects but do presumably exists in both.

In sum, Figure 20 shows that the overall average of the data indicates that equivocality is more significant in the FE of radical projects, than in incremental ones. However, the gap between the two types of NPD is relatively small due to the strong arguments from each side. Independent of if the project is radical or incremental, there seems to be a relationship between the frequency of communication and the impact of equivocality.

5.1.3 Complexity

Complexity, which is defined as “a large number of parts that interact in a non simple way” (Simon, 1969 p. 195; Zack, 2001 p. 3), is the last IPP to be discussed. From Figure 21 it is evident that radical projects, once again, were rated as having a higher significance than incremental ones. The explanation is found in connection to the number of novel aspects that is involved in the product being developed. As complexity represents the issue of many parts that interact to create something greater, it is the novelty of those many parts that is the challenge to meet.

Complexity represents the difficulty of combining several bases of knowledge into a greater one (in this case a knowledge base represents the sum of knowledge one has on a specific item, concept, or component). In the FE of radical projects several of those knowledge bases might be completely novel to the firm. The point being that it is difficult to develop a product where one does not understand the components or the technologies it consists of. In incremental projects on the other hand, one has already mastered all aspects, except perhaps one, which is the aspect that the firm aims to upgrade the product with. Zeta (16-04-2015), whose current employer is a large car manufacturer, explains it like this “…cars, as we all know, consists of thousands components that needs to interact without fail. We always upgrade our cars and somehow we manage to keep track of all things.” Zeta explains that even if the car itself is a complex product, the firm has managed to understand and make sense of each component (knowledge base) and smaller upgrades (incremental projects) are therefore not a major concern of theirs. In the FE of radical projects on the other hand, the firm ran into significantly more trouble. Zeta (16-04-2015)
once more elaborates “Even though this happened a long time before I started working here, I have been told that the transition from the analog car to the digital one (computerized) was one of the biggest projects for us… or as you put it, one of the biggest radical projects.” The project of digitalizing the car became so challenging for the firm because the project was of a pure radical nature. Zeta (16-04-2015) continues “It was not only to mount a computer under the hood, each single component that needed to communicate with the computer were to be reevaluated and changed”. Zeta’s reasoning reflects the main points made by many of the respondents and it explains why Zeta rated the significance of complexity in the FE of radical and incremental NPD as 70 and 18 respectively.

During the interview and discussion with Delta, another interesting insight of complexity was reached. Delta, who currently works as an NPD consultant, exclusively with FE activities, pointed out the challenges connected to acquiring knowledge of customer’s preferences and translating those into products of high usability. “When working as a consultant you constantly meet new customers and one of my biggest challenges is to understand the customers preferences so that I can develop a product that fits their need” (Delta, 17-04-2015). For Delta it was not only about developing and putting together, for example a toaster, where one needs several knowledge bases to understand. Instead the biggest issue was to gain knowledge about the usability of the toaster and incorporating that knowledge with the original components. Delta’s main conclusion was that complexity does not only surround the components of the product that one can see or feel. It also includes softer and more abstract components. 1

In line with Zeta’s example of digitalizing the car and Delta’s reasoning about soft components, Gamma explained that one of the biggest challenges for the current employer was the issue of hardware/software- interface. Gamma (14-04-2015) said that “I find it much easier to fit together hardware like a puzzle, than to include software and make the whole thing so much fuzzier”. Software could actually be used to represent a metaphorically embodiment of complexity. Often software’s main function is to manage communication between different parts or components, makings sure the product’s functions work as one. It enables the large number of parts to interact in a non simple way, creating a product that work as it is supposed to. In sum, software enables complexity as it allows for communication or interactions between components. At the same time software is part of the solution of reducing complexity as it, in most cases, makes communication much more efficient compared to previous methods (mechanics being one).

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1The example of customer preferences and usability is actually a perfect scenario in the sense that it includes all three IPPs. Firstly, there is a challenge in processing the intended information from correct sources so that the knowledge becomes reliable (uncertainty). Secondly, even if the firm thinks it has gathered the correct information, how can one be sure that it actually reflects the real world or the needs of the firm’s specific customer segment (equivocality)? Lastly, let us assume that the firm has overcome the first two challenges; can the knowledge gained about customer preferences be incorporated into the product in a satisfying way (complexity)?
In sum, complexity exists in the FE of both radical and incremental NPD, but due to the extent of novel components, or knowledge bases, they differ in terms of significance. They differ in how many new knowledge bases that needs to be combined, but also to the extent of how much the customer’s preferences changes. As radical NPD per definition results in a new market infrastructure, the number of new soft components that needs to be incorporated into the product’s usability is greater than in incremental NPD where the market does not change.

5.1.4 Outliers

When gathering subjective data the results may have a wide dispersion as it mostly builds on perceptions based on that individual’s prior experiences. This phenomenon is also true when subjective data is presented via quantitative measurements. For this study, a majority of the collected data is presented in numerical form (typically a quantitative measurement) but represents subjective data (e.g. perceptions, opinions, or interpretations). This would explain why sometimes some ratings did not follow the pattern seen in other respondent’s ratings. Some ratings seem extreme and therefore needs to be discussed in order to be understood. Once again, the significance ratings per IPP and respondent are shown in Figure 22.
The first odd rating that comes to attention is Delta’s significance rating (100) of uncertainty in radical projects. Delta has had several different employers over the years but the majority of that experience comes from working as a consultant, conducting FE activities on a daily basis. Delta (17-04-2015) explains the ratings by saying “…I will rate both frequency and impact as a ten because when I get radical requests from my customer, sometimes all aspects of the product is completely new to me.” The situation were all aspects of a product is completely new to the firm could be argued to occur more often for consultants than others as they meet a large variety of different customers need constantly. So the significance rating of a 100 could be explained by the fact that Delta is most influenced by the experiences from that line of work.

Another ratings that stand out among the crowd is Eta’s ratings of complexity in radical (4) and in incremental (2) projects. At present Eta has 25 years of experience working with a certain type of product and have been part of that very product’s birth and development ever since. Eta feels confident in all aspects of the product and do therefore not consider it as complex. Radical projects dictate that some aspects have to be completely novel to the firm and therefore one cannot possess the knowledge in beforehand (Garcia & Calantone, 2001). To this Eta (24-04-2015) replies “I know this product inside out. The same for the market it is on. It is fairly easy for me to predict in what direction the technology development is going.” Since Eta believes to “know what there is to know”, complexity becomes a minor problem for the radical projects he supervises and even less so in the incremental ones. The low ratings in complexity could be explained by the overconfidence Eta possesses. This kind of arguments has not been observed in discussions with other respondents.

Epsilon’s rating of equivocality (1) in incremental projects is far lower than the average in that category. Epsilon (17-04-2015) explains why the rating is so low. “All NPD activities are done in-house and are normally conducted by the same people every single time. So misconceptions rarely occur as we “speak the same language” and we all sit in the same office building”. As previously indicated, a high frequency in communication results in lower impacts of equivocality, and since the project members of Epsilon’s team knows each other well, misconceptions seldom occurs. This reasoning seems to be in line with all conclusions drawn so far in this discussion. However, the example Epsilon gives is based on a case from the current employers, perhaps only applicable to that specific firm. Eta shows an inability to separate the current employment from the total experiences from all the former employers Eta has had.

### 5.2 Significance distance

Now that it has been established that IPPs in the FE are more significant in radical than in incremental ones, it is time to discuss what that exactly entails. What does that difference mean? Why is it of interest for someone to understand? Well, it turns out that the differences in significance between radical and incremental projects are essential when designing and structuring the FE phase.
As significance indicates how crucial or important an IPP is to the project’s smooth progress, a high value represents an IPP that needs to be prevented or eliminated immediately (compared to an IPP with low significance that is). Figure 23 shows that there is a difference in significance in all three IPPs in favor of radical projects being the higher rated one. But the difference between radical and incremental projects in uncertainty is far greater than in complexity. Even more so in the case of comparing uncertainty and equivocality. The difference is as follows:

\[
\begin{align*}
\text{Difference in significance of uncertainty} &= 61.1 - 16.1 = 45.0 \\
\text{Difference in significance of equivocality} &= 37.6 - 27.3 = 10.3 \\
\text{Difference in significance of complexity} &= 44.6 - 15.4 = 29.2
\end{align*}
\]

Equation 2. Difference in significance of IPPs

Figure 24 is a simplification of Figure 23 where the bars have been replaced with curves, which correlate to the same values that the previously bars had. In this way, the significance differences can be visualized as significance *distances* instead, which makes the result more comprehensible.

In this study it has been mentioned multiple times that the FE of radical and incremental projects needs to be approached in different ways (Durand, 1992). The distance in significance of the IPPs indicates how that approach should be designed. Let us say that a person is set with the task of designing two separate FE phases; one fit for radical products, one for incremental ones. By studying the distance of significance the designer now knows how diverse those phases should be.

As there is a large distance in uncertainty, the two approaches needs to consist of different levels of preventive or reducing activities. In a radical project, there needs to be plenty of such activities as uncertainty is high. In incremental projects the designer can focus more on other issues as uncertainty is not as high. The reversed logic can be applied to an IPP with a small significance distance. When a person is designing the FE phases with equivocality in mind, the difference between radical and incremental projects should not be so big. Instead the two FE-phases could
be more similar and more standardized. Having a standardized FE phase, independent if the product is radical or incremental, enables collaboration of resources and efforts.

However, the real challenge does not lie in identifying the exact distance in significance. Instead it lies in interpreting that significance so as it makes practical sense for the project at hand. For example: Is a distance in significance of 10,3 in equivocality enough to justify a totally standardized solution? For some projects, sure. For others, maybe not. The conclusion in regards to the IPPs significance distances is merely an indication or suggestion to keep in mind while designing the FE-phase.

In sum, the larger significance distance, the more diversified radical and incremental FE phases needs to be. Furthermore, this also means that: a small distance in significance allows for a more similar and standardized FE phases.
6 Conclusion

This concluding chapter will summarize and highlight the conclusions that were drawn in the discussion. The conclusions have implications both in managerial and theoretical terms. The managerial implications are those that affect firms that aim to use this study in order to improve their FE. The theoretical implications are connected to the research field of FE and NPD, and how the conclusions held up against the expectations of the authors.

6.1 The main findings explained

This study was initiated as a response to the growing need for firms to improve their NPD process (Lin & Chen, 2004). Today, firms face the challenge of making their NPD process faster, smoother and more efficient if they are to remain competitive (Smith & Reinertsen, 1992). Prior literature on the subject pointed towards the FE, claiming that it represented one of the biggest areas of improvement (Koen et al., 2001). It became clear that if firms managed to reduce the lead-time of their FE, without a quality tradeoff, they could introduce novel products faster than the competition. This would lead to less waste and more profit. The FE is often deemed as an informal and fuzzy phase of the NPD, due to that many firms lack an organized structure guiding it (Kim & Wilemon, 2002). The FE is also the part of the project where information is processed into new knowledge needed to create and understanding of the novel aspects of the product (Chang et al., 2007). Prior research has proven that many problems arise during the FE and it could be argued that many of these problems are the result of a lack in proficiency in information processing (ibid). The IPPs therefore became the area of the FE, which this study investigated. It was decided that the IPPs should be compared between radical and incremental projects so as to see if there was any difference in their significance to the project. If so, some conclusions could be drawn of how to manage the two types of FE differently. The research question of the study reflects this reasoning:

How do information processing problems vary, in terms of significance, in the Front End of new product development when comparing radical and incremental projects?

In order to find an answer to the research question, a literature review was needed as an initial step. The result of the review became the base of secondary data, which was later used during the data analysis. Theories about NPD, FE, information & knowledge, and IPPs were the main building blocks of that base. In order to collect primary data, seven case studies were conducted in form of semi-structured interviews. The respondents were chosen based on the condition that he or she had extensive experience working with NPD of goods within Swedish firms.

Two main conclusions, and a secondary one, were reached after the investigation. The first main conclusion was that the IPPs in radical projects were more significant than in incremental ones. This was true for all three IPPs. Uncertainty represented the most significant IPP in radical projects, and the second most significant in incremental ones. Equivocality was rated as the
highest IPP in incremental projects, and the lowest in radical ones. Complexity was the second most significant IPP in radical projects, and the least significant in incremental ones. There were some odd ratings indicating a different result, but these had a logic behind them, explaining why that specific rating did not follow the pattern seen in other respondents. Overall, the ratings of the IPPs in the data analysis pointed in the same direction. The first conclusion therefore answers the research question of the study: The IPPs does vary, in terms of significance, in the FE, when comparing radical and incremental projects. They are far more significant in radical projects, meaning that they occur more frequent and have larger impacts on the project.

The second major conclusion came as a natural consequence of the first. It is not sufficient to know that there is a difference, but one must understand why there is a difference and what it means for the NPD process. The second conclusion was drawn in connection to the significance distances of each IPP. The significance distance describes the differences in significance for each IPP in regards to radical and incremental projects. The outcome was that uncertainty had the biggest significance distance, indicating that there is a big difference in how radical and incremental projects should be approached in the FE. Radical projects need to be designed so as to prevent or reduce uncertainty to a higher degree than in incremental projects.equivocality showed the shortest significance distance, meaning that radical and incremental projects could be designed fairly similar. The larger the significance distance, the more diversified design of the FE is needed. When a firm is to initiate a new project the process and structure sometimes looks different depending if the product is a radical or incremental one. The structure could differ in terms of activities conducted and in the constellation of the project group. The second conclusion assists firm’s decision making process as it supplies findings that could help them in designing those activities and constellations. Part of the study’s research purpose is thereof answered. The part aiming to explain the possible differences in significance, and what those differences entail.

Another conclusion was made concerning the role of communication in enlarging or reducing the impact of equivocality in the FE. It turns out that the more often persons, departments, or firms communicate with each other, the bigger the chances are of detecting and resolving an equivocal situation. As long a misconception exists it enables parties to work under false pretense, wasting resources and perhaps even creating negative repercussion further down the road. This conclusion is relevant for both radical and incremental projects.

### 6.2 Managerial implications

The first and second conclusion stresses the importance approaching radical and incremental projects differently. It is true that some of the respondents’ current employers already did have differentiated approaches for radical and incremental products, but none of them were deliberately designed to meet the challenges of all three IPPs. Most firms were focused on reducing uncertainty alone. In other words, the current approaches of the FE are not perfect and perhaps far from it. The conclusions of this study are therefore most relevant as the managerial implications of them could help firms to improve the overall performance of the FE. By
understanding that the IPPs vary, the FE process and its activities could be more accurately designed in order to face the most crucial problems first and not wasting efforts eliminating those IPPs of less significance. Table 3 presents some suggestions for firms to take. The recommended actions themselves are not part of the findings of this study, but are instead based on prior research that is presented in Chapter 2.4.

Table 3. Recommended actions to reduce the IPPs

<table>
<thead>
<tr>
<th>NPD type</th>
<th>IPP</th>
<th>How to reduce the IPPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radical High significance</strong></td>
<td>Uncertainty High (61,1)</td>
<td>As uncertainty is high, extensive preventive actions are needed. One way of reducing uncertainty is to acquire more information, which is processed into knowledge that fit the task. Firms should therefore spend more effort on research, or investigations, aiming to acquire additional information. One alternative way could be to buy knowledge from an external source (consultants). When uncertainty is this high, it would be recommended to allow for some slack resources in the project, in case that unseen complications arises. In this way, the firm increases its ability to tolerate uncertainty.</td>
</tr>
<tr>
<td></td>
<td>Equivocality Low (37,6)</td>
<td>In radical projects equivocality is relatively low, meaning that efforts are needed, but not as extensive as for the other IPPs in radical projects. Firms should allow and encourage frequent communication between project members and parties as it was concluded that this would lower the impact, and in extension the significance, of equivocality. Another action firms could do is to in the beginning of the FE have a sit-down with all project members, explaining each aspect of the plan in detail, facilitating circular discussions. In this way less room is given for misconceptions.</td>
</tr>
<tr>
<td></td>
<td>Complexity Intermediate (44,6)</td>
<td>Complexity in the FE of radical projects is of intermediate relative significance. However, this significance level more than justifies initiatives being made aiming to reduce complexity. By breaking down each single component and making it as simple and understandable as possible, the complexity will be reduced. However, in order to make sense of those simplified components, cross functional teams could be established in order to mix people with differentiated knowledge, creating a natural forum for collaboration.</td>
</tr>
<tr>
<td><strong>Incremental Low significance</strong></td>
<td>Uncertainty Intermediate (16,1)</td>
<td>In the FE of incremental projects, uncertainty is of less significance. In addition, the significance distance to radical projects is great, which means that far fewer actions are needed in order to reach an acceptable level of the IPP. However, if a firm is aiming at keeping the uncertainty to minimum, similar actions could be taken as those in radical projects.</td>
</tr>
<tr>
<td></td>
<td>Equivocality High (27,3)</td>
<td>Equivocality is the IPP that requires the most attention in incremental projects. Since the significance distance is low, equivocality should be approached in a fairly similar manner as in radical projects. Firms should encourage frequent communications, circular discussions, and at the beginning of the project they should define concepts that otherwise could create equivocal situations.</td>
</tr>
</tbody>
</table>
Complexity in the FE of incremental projects has the lowest significance level of them all, all categories considered. This fact, could lead some firms to fully ignore this IPP and solely focus on uncertainty and equivocality. However, we would recommend firms to at least consider complexity and figure out if the significance level of the IPP is acceptable or not.

In a perfect scenario, the FE would have no IPPs at all. However, that state of a project is impossible to reach. Some IPPs will always exist, but firms must face the challenge of finding an acceptable level. What an acceptable level of IPPs is, depends on the firm and the project at hand. That is left to the project management to decide. The more actions, tools, or systems that are implemented in order to reduce the IPPs, the more static, costly, and bureaucratic the process becomes. As the FE includes idea generating and other creative activities, having a bureaucratic and a non-flexible process would seem to be contra productive. Therefore, firms must find the acceptable level of the IPPs, making tradeoffs between IPPs elimination and bureaucracy. By finding this level, a balance, and a more resource efficient FE would emerge.

One beneficial outcome of having a more proficient FE process is that the total lead-time could be reduced. However, speed is not always a good thing in the FE, as creative activities need time in order to reach good results. An improved process should be reached by reducing the IPPs without sacrificing the quality of the product. By improving the FE, firms save both time and money, and can instead relocate its resources into other areas that are in need of attention. Firms could then allow more slack in resources dedicated to the more creative activities in the FE. By doing so, more resources could be spent on coming up with competitive ideas and innovative products, rather than solving unnecessary problems reactively.

6.3 Theoretical implications

This study brings value to the academic society as it brings new, previously unseen, conclusions of the dispersion of the IPPs within the FE. The study contributes in creating further understanding of how the IPPs behave during this phase. According to Bryman and Bell (2011) qualitative research is a helpful tool in creating ideas, from which hypotheses can be derived and tested by using a quantitative research strategy. It could therefore be argued that this study provides a good basis for further and more extensive research. It enables further research that could be used in the creation of methods of how to reduce the IPPs in the FE. Some such methods or tools already exist. However, after learning about the dispersion of the IPPs, these tools can be further improved so that they fit the current project more accurately.

1.3.1 Connection to prior research

At present, there are a large number of researchers who study the FE, hoping to reach conclusions that, inch by inch, lead the research field onward. This study and its conclusions contribute to this collective collaboration by adding insights previously unseen. Frishammar et al. (2011) are
researchers whom have also investigated the IPPs in the FE. The conclusions of this study do not oppose the other authors, but instead goes in parallel with their general impressions of how the FE functions and how it works. This study has treated the FE as one single continuous phase and has made no distinction between the different activities taking place within. Frishammar et al. (2011) divide the FE into three sub-phases, and compares equivocality and uncertainty in those phases. Their findings show that uncertainty and equivocality indeed is more or less important throughout the FE. A suggestion for further research would therefore be to take the research concept of this study and see how the IPPs’ significance varies during different activities of the FE. By doing that, while at the same time comparing radical and incremental projects, more precise conclusions could be drawn. Another conclusion that Frishammar et al. (2011) make is that firms should focus more on equivocality reduction in the earliest stage of the FE, and on uncertainty reduction in the later stages. This is due to the results of their data analysis, which showed that equivocality was high in the beginning of the FE. This conclusion was expected and indeed confirmed in this study. Gamma (14-04-2015) pinpointed the conclusion when stating: “When things are new there is often a period of time in the beginning of a project when a lot of misinterpretations are made”. Frishammar’s et al. (2011) research findings were therefore partly confirmed through this study.

Chang et al. (2007) in their study Conceptualizing, assessing, and managing front-end fuzziness in innovation/NPD projects indicates and argues briefly about the positive aspect of IPPs in the FE. This study has considered the IPPs as only being negative and undesired problems, which firms should always eliminate. However, Chang et al. (2007) have a good point being that firms learn valuable knowledge each time they overcome an IPP. It is logical to assume that the more IPPs a firm overcomes, the more skillful and knowledgeable it becomes, making it more competitive on the market. By facing the IPPs, “head on”-firms investigate in long term profitability, as the second time the same IPP occurs the firms already know how to handle it. To this day, there is no extensive research of the positive aspects of the IPPs. However, the results of that sort of research would be most interesting to take part of.

Another interesting parallel between Chang’s et al. (2007) and this study is connected to the definition of equivocality. On top the common definition of equivocality as “a situation where multiple interpretations of a specific item exist”, Chang et al. (2007), also presents and alternative point of view. They add “ignorance of existence” as a part of equivocality (ibid). Either the persons in a project group are unaware of the true meaning of an item, or they will have diversified interpretations of it. After investigating equivocality in radical and incremental projects, Chang’s et al. (2007) addition to the original definition, makes a valid point. It could be hypothesized that the nature of equivocality differs between the two types of projects. During the interviews it was indicated several times that in radical projects, equivocality occurred more in terms of “ignorance of existence”, because many aspects of the project were novel to the project members. They simply did not know the true meaning of the item. In incremental project fewer aspects are novel, and the equivocal situation instead revolved around “multiple interpretations of a specific item”. As this is phenomenon is theorized by Chang et al. (2007) and indicated during
the interviews of this study, it is possible that equivocality behaves as two separate IPPs instead of a single one, depending if it occurs in radical or incremental projects. If so, it is likely that equivocality needs to be managed and reduced in different ways. Therefore it is strongly recommended for future researchers to further investigate how equivocality behaves differently during different kinds of NPD projects, possibly leading to less wasted efforts and less frustration among project members.

As mentioned in the theory, Chapter 2, this study has investigated each of the chosen IPPs separately in order to fully understand them. However, as mentioned by Zack (2001), the IPPs constantly influence and affect each other. Zack (2001) even proposes that there is not a single situation where only one IPP exists. This fact became apparent during the collection of empirical data. Discussions were held with the respondents, in relation to question 13 (Appendix 1), if he or she deliberately worked with IPP reduction in the FE. Some of the respondents claimed that they had activities during the FE, which was aimed to reduce uncertainty, but not equivocality and complexity. However, after some discussion it was concluded that they actually, unknowingly, did reduce more than only uncertainty. As the IPPs interact with each other it is logical to assume that in order to reduce one IPP, others need to be reduced as well. Sometimes, the reverse is applicable; if one IPP is reduced, others will be reduces as a results. A clear example of the IPPs interactions is connected to the relationship between complexity and uncertainty. It is believed that for highly complex products, e.g. a car, some uncertainty cannot be reduced until complexity is firstly taken care of. While developing a car in a radical project uncertainty is high as the firm lacks knowledge of the novel aspects of the car. In order to reduce uncertainty, additional information is needs to be processed into applicable knowledge. However, in order to know what information the firm is in need of, each component of the car needs to be broken down and studied (reducing complexity). Once each component has been broken down and simplified, it will become apparent for firms what kind of information it needs. So, in order to gain more knowledge and reduce uncertainty, complexity firstly needs to be reduced. (This phenomenon leads the authors to believe that if one fully understands the interactions and relationships between the IPPs, firms can minimize the amount of activities needed to find an acceptable level of the IPPs. In an ideal situation, one single act in the FE could start a chain reaction, reducing all three IPPs at the same time. In order to gain knowledge of the IPPs relations, more research is needed.

1.3.2 Expectations of the authors

When starting this investigation, the authors had some expectations of the outcome and findings. Some of them were fulfilled, while others were disproved. It came as no surprise that uncertainty was rated as the most significant of all IPPs in radical project. This result had been theorized in prior research. However, it was a surprise that uncertainty did not score the highest significance in incremental projects. Instead, equivocality was rated as having the highest significance. This result had not been shown or theorized in prior research. This most interesting conclusion opens up to an array for possible future research topics. Could it be that researches and firms have
underestimated the significance of equivocality? However, it could also be argued that the limited empirical data of this study has led to misleading results. As this study has shown results previously unseen, it would be most interesting to make a more extensive study, with far more empirical data collected, trying to prove or contradict this study’s result. If such a study would show the same results as this study (that equivocality is the most significant IPP in incremental projects), researchers and managers need to drastically rethink the way they research or manage IPPs in the FE.

No research study is perfect. In hindsight, there are some aspects of this study that could have been improved or revised. One such aspect is connected to the accuracy of the respondent’s answers during the interviews. This study contains few restrictions or limitations in regards to the chosen case study objects. In fact only three such limitations exists: That the respondent had experiences of developing goods (not services), had major experiences working in the FE, and had experience working for a Swedish firm. This meant that the study was not interested in how firms perceive the IPPs, but how individuals perceive them. The study aimed to collect data that reflected the person’s entire working experiences, not only from its current employer as the IPP presumably are more or less significant depending on what type of product that the employer was developing. It was the expectation of the authors that this request would pose no challenge. However, the respondents had trouble separating their current employment from their “life time experience”, which is why some ratings probably are influenced to a larger extent by their current employment and that firm’s product portfolio. The blame cannot be laid on the respondents, but instead is the result of a questionable design of the data collection process. For future studies it would be recommended to narrow down and tighten the requirements of the chosen case studies. It would be advantageous for such a study to investigate a specific type of goods, instead of every single goods there is as this study has done. For example, during the ratings of the IPPs, the results differed depending on the nature of the product that the current employer develops. In that aspect, this study is considered too general. High tech, complex (many components), or a mixture of hardware and software, are but a few of product categories, which could have been specified in order to get a more precise result. By focusing on a specific industry or product type, results akin to that of this study, could be achieved. By narrowing down the results to a category makes it easier for that study to more accurately recommend an action plan in order to reduce the IPPs in the FE. Once a reliable dispersion and significance distances have been established for a specific category, the work related to designing best practice methods or tools can commence.

One of the limitations when choosing case studies were that the respondents needed experience from working within Swedish firms. This limitation was the result of the expectation of the authors that culture would influence the way firms manage their FE. Different cultures, and their norms, would directly influence priorities, structures, and scheduling of the projects. This expectation was confirmed during one of the interviews where the respondent had experiences working with NPD at remote R&D-departments in both Germany and China. The respondent confirmed that even within firms the FE may look different depending on where in the world it was conducted. As it is no secret that the business markets are becoming more global each year
that passes, a study comparing how different cultures see, manage, or conduct their NPD projects could contribute in designing differentiated FE phases. This topic would be most interesting for global or multinational firms who conduct NPD at different locations of the globe.
7 Bibliography


Appendix 1 – Interview guide – Translated from Swedish

Interview guide

Background questions:
1. What prior work experiences do you have?
2. What is your current position/title and who long have you been working with NPD?
3. What are your main responsibilities?

The Front end of Innovation
4. Do you have experience working with FE activities?
5. Could you describe how the FE is normally structured?

Information processing problems in the FE
6. Are you familiar with the IPPs uncertainty, equivocality, and complexity?
7. Could you give some examples of some issues in the FE where the IPPs were the cause?
8. What do you think is the main reason that the IPPs occurs?
9. What implications have these IPPs had?

IPP’s in radical and incremental projects
10. Do you have experience working in the FE of both radical and incremental projects?
11. Would you say that all three IPPs are present in both radical and incremental projects?
12. Thinking back on your work in radical and incremental projects: Please describe the main differences.
13. Do you deliberately work with reducing the IPPs in the FE?

(The answers to question 14-17 were documented on a questionnaire, appendix 2)

14. According to you, on a scale from 1 (very low) to 10 (very high), how often does the IPPs occur in the FE of radical projects?
15. According to you, on a scale from 1 (very low) to 10 (very high), how often does the IPPs occur in the FE of incremental projects?
16. According to you, on a scale from 1 (very small) to 10 (very large), how large is the impact of IPPs in the FE of radical projects?
17. According to you, on a scale from 1 (very small) to 10 (very large), how large is the impact of the IPPs in the FE of incremental projects?
Appendix 2 – Complementary questionnaire – Translated from Swedish

**Frequency**

According to you, on a scale from 1 (very low) to 10 (very high), how often does the IPPs occur in the FE of radical projects?

1) **Uncertainty**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

2) **Equivocality**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

3) **Complexity**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

According to you, on a scale from 1 (very low) to 10 (very high), how often does the IPPs occur in the FE of incremental projects?

1) **Uncertainty**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

2) **Equivocality**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

3) **Complexity**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

**Impact**

According to you, on a scale from 1 (very small) to 10 (very large), how large is the impact of IPPs in the FE of radical projects?

1) **Uncertainty**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

2) **Equivocality**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

3) **Complexity**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

According to you, on a scale from 1 (very small) to 10 (very large), how large is the impact of the IPPs in the FE of incremental projects?

1) **Uncertainty**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

2) **Equivocality**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

3) **Complexity**
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10
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