

The Application of Futures Studies in Innovation Processes

Scenario methods as a tool to facilitate flexibility and enable
future resilient products

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Abstract

Companies are pressured by dynamic markets and the increase of innovation speed, technology change and shortening of product life cycles. They need to attend to customer demands and ever-changing environmental conditions, policies and regulations set by governments and institutions in order to stay relevant on the market and be allowed to operate. Innovation has therefore become a must and the innovation processes are a central part of companies' operations. Futures studies is presented as a systematic way of studying the future that can contribute to a better understanding of the needed direction of innovations. The aim of the study is to investigate how futures studies can be embodied in the innovation process of manufacturing companies in the industry of rail and road vehicles.

The structure of an innovation process within the industry of rail and road vehicles is summarized to consist of three different phases: the fuzzy-front-end, the development and the maintenance. The innovation process is further divided by the components of the product and during the entire process there are decision points to evaluate the projects. The organizational aspects which are considered to have the most influence on the innovation process concern the company environment and internal knowledge sharing. Futures studies are moderately performed at different stages of the innovation process and levels of the organization, mainly at corporate level and in the fuzzy-front-end. The people involved in these activities are solely employees from the company in question and the main issue found regarding the activities of futures studies is that the results of the foresight are not communicated properly across the company. Two ways in which futures studies can be embodied in the innovation process are identified to create more high-quality ideas and to tune the product during the process according to the future market, with a third way ensuring alignment with corporate level.

A recommendation is presented consisting of a scenario workshop which enables for futures studies to be embodied in the innovation process of manufacturing companies. Activities and pointers for prior, during and after the workshop are presented. The results of the workshop will further be embodied in the innovation process in three different ways, in the beginning, alongside and as a basis for the corporate strategy.

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1. Introduction

One of the greatest concerns for many companies and corporations is how their business will fit into future markets. Dynamic markets are putting pressure on both development activities and innovation speed as well as the strategic management of the organizations. They must act quickly on customer demands and at the same time battle the ever-changing regulations. Governments and institutions are constantly setting new targets to reduce greenhouse gas emissions and waste to enable industrial sustainability, much like the European Union's targets for its member countries (European Commission Climate Action, 2015). Furthermore, consumers are demanding that the industries take responsibility for their actions and many companies are incorporating sustainability into their corporate strategies to create products and services which will accommodate the future. This makes it essential for companies to keep up with the changes made and to prepare for future changes to policies and regulations in order to stay relevant on the market.

According to Dilara (2015) innovation is an important element for companies in order to survive global competition and enhance economic development and growth. Innovating has therefore become a must rather than an advantage for companies in present markets. Even though the definition of the concept innovation may vary throughout scholars and industries the content of the definition in this paper is consistent with the literature. An innovation can be described as a "commercial feasible version of an invention" (Dunphy *et al.*, 1996, p. 279), or an "invention implemented" (Buderi, 2000, p. 30). Therefore, the innovation process describes the journey from the spark of an idea to an implemented concept that brings value to its user and/or creator. Chesbrough (2003) stresses the importance of treating new ideas with alacrity in order not to lose them, since useful knowledge has become widespread. It has become common for firms and whole industries to engage with others to share their knowledge and learn from each other (Chesbrough and Appleyard, 2007). The sharing of knowledge is one way to enhance innovation, but it is in itself insufficient to provide a company with the flexibility to combat any possible future problems.

Futures studies has long been used with the aim of establishing a plan for the future that minimizes the surprises as well as facilitates for managers to keep different possibilities in mind while planning for the future (Mietzner and Reger, 2005). Given that the future is unknown and uncertain, van't Klooster and van Asselt (2006), argue that different and even contradictory perspectives can possess the opportunity to lay a foundation for a genuine and credible explanation of how the future may unfold. By exploring the future in a structured way Börjeson *et al.* (2006) claim that actors can develop flexible strategies to withstand possible future developments.

As both environmental conditions, policies and regulations are inconsistent over time and changes can be expected to fluctuate even faster it has become of high importance for industries to embark on a flexible strategy to quickly adapt to market dynamics. These dynamics are driven by increased innovation speed, increased technology change, increased speed of the diffusions of innovations and shortening of product life cycles (Rohrbeck and Gemünden, 2011). Innovation is essential for solving future problems and continuous innovation processes are a necessity. Duin (2006) argues companies tend to overestimate the level of flexibility possible to make changes during the development process but he claims futures studies can help direct companies' investments and

make sure time and resources are used for developing ideas which possess the potential of having a successful implementation on the future market. By performing analyses and evaluations during the innovation process futures studies can be used as a continuous element to reevaluate projects and ideas as the outlook of the future alters. Futures studies thereby possess the chance to provide an overview over possible future conditions and contributing to a better understanding of the needed direction for innovations.

In order to investigate how futures studies can be applied in innovation processes manufacturing companies within the industry of rail and road will be examined. These companies are broadly affected by the rapid changes and developments of technology and innovation and are constantly under pressure to be in the forefront of developments to stay relevant on the market. This industry's operations, like many other industries, are influenced by the dynamic markets and the constant changes to policies and regulations are crucial for their right to conduct their business. As their products are costly to produce and aimed to be used for decades, they need to plan well ahead to make sure their products are relevant on the market once they are launched and the years that follow.

1.1. Purpose

The aim of the study is to investigate how futures studies can be embodied in the innovation process of manufacturing companies in the industry of rail and road vehicles.

1.1.1. Research Questions

The following research questions have been stated:

1. How are innovation processes for companies within the industry of rail and road vehicles structured and what organizational aspects influence this process?
2. To what extent is futures studies being used in the industry of rail and road vehicles?
3. How can futures studies be embodied in innovation processes to enable more future resilient innovations?

1.2. Research Center for Vehicle Design

A research center at a university in Sweden is the basis for this study. The center involves research within resource efficient vehicles to enable a sustainable transport system in Sweden and is part of a larger system of centers and research groups focusing on transport and vehicles. The center is made up by 14 partners from academia, industry, small and medium-sized enterprises and public authorities. The partners compose of major companies within the vehicle manufacturing industry in Sweden as well as public authorities connected to the transportation system and other companies linked to vehicle design. The larger part of the Swedish transportation industry is thereby represented in the center and together they possess expertise within areas such as vehicle dynamics, life cycle analysis, system science, modularization and more. The aim of the center is to enable collaboration where the partners can complement each other's competences and meet interdependency needs to explore the social, environmental and economic aspects of the transport

and surrounding systems. The companies' involvement enables them to get inspired by each other and to spread the information from the researcher in the center to the active vehicle manufacturers in the Swedish industry. By working together and learning from each other the goal is that interdependencies can be overcome to achieve environmentally friendly and economically competitive rail and road vehicles.

The center enables a good setting for this study as it comprises of large players within the industry of rail and road vehicles who all have an interest in making their products more future resilient, and thereby enable them to withstand the changes of the future whatever they might entail. This enables the study to make use of the center during the collection of empirical data and to make the most of the knowledge exchanged in the center.

1.3. Limitations

This study examines manufacturing companies in the Swedish industry of rail and road vehicles. Although the companies involved in the study operate on the global market, only the Swedish procedures are investigated. This study will examine how futures studies can be embodied in the innovation process but excludes the examination of how innovation processes can be embodied in futures studies.

2. Theory

This chapter presents theories regarding innovation processes and futures studies which are identified as valuable and will form the basis of this study. Following, a section with theories regarding the intermediate connections between the two areas. Finally, an analytical framework is presented with its basis in the presented theories which will function as an analytical tool for evaluating and analyzing the empirical findings of this study.

2.1. Innovation Processes

The distinction between an invention and an innovation is realized through the process it goes through. Duin (2006) describes this as the way in which ideas are generated and transformed to new products that are subsequently introduced to the market. Therefore, the focus of innovation in this study will be the process which it encompasses. More specifically the product development process, consisting of the activities and steps involved in a project moving from the idea generating to value being captured by its user or creator.

Innovation processes are highly influenced by the environment and internal knowledge sharing of the company in which they are performed. According to Duin (2006) these processes are most often managed and nurtured in specific innovation projects in the context of a company's organization. For a company the knowledge which its employees possess and the processes it has implemented creates their capability of innovation. By investigating different theories summarizing patterns of reality, a better understanding of the symbiosis within the companies can be achieved and actions can be taken to enhance the promotional conditions for an innovation process.

2.1.1. The Structure of Innovation Processes

According to Eppinger and Ulrich (2012) a product development process comprises a set of stages and activities which are followed and although some companies follow a detailed process for this, many companies find it hard to describe the process they are using. They argue there might even be different development processes for different projects and departments within the same company. A generic product development process as described by Eppinger and Ulrich (2012) consists of six different stages presented below and in Figure 1.

- *Planning*: where initial opportunity is identified and the project mission is stated concerning target market and business goals.
- *Concept development*: where the customer needs are identified and product concepts are generated and evaluated.
- *System-level design*: where the architecture of the product is developed and plans are set for production and assembly.
- *Detail design*: where for example the geometry, material selection, tolerances and production process plan are determined in detail.

- *Testing and refinement*: where pre-production versions of the product are tested both internally and with customers to identify necessary changes.
- *Production ramp-up*: where a gradual transition from small to large scale production is carried out refining and solving problems within the production process.

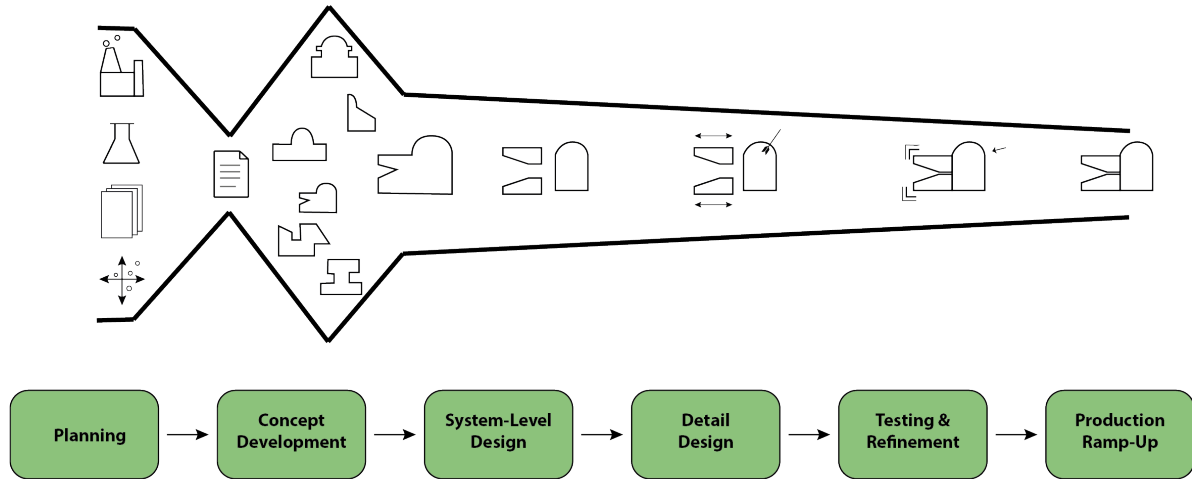


Figure 1: A generic product development process and its activities as described by Eppinger and Ulrich (2012).

The generic product development process as described by Eppinger and Ulrich (2012) is as stated very generic and enables for a wide interpretation of how to structure and apply the theory to a product development process. This suggests that the process described should also match the description of most product development processes presently used and enables a good starting point for translating and understanding these processes within companies. Although to enable an understanding of how futures studies can be applied within innovation processes theories concerning product development processes need to be explored in more depth.

Another product development process which describes the innovation process in more depth and detail is the Stage-Gate process, see Figure 2. The process is largely used by companies developing new products and can help clarifying further what activities are usually involved in the different stages and phases. It can further facilitate identifying where futures studies would be most useful and of most relevance to implement. The Stage-Gate process is built up by five different stages which are composed of a set of recommended activities to gather information and reduce uncertainties and risks within the project (Cooper, 2008):

- *Discovery*: where new significant product opportunities and ideas are generated. Scenarios are created by analyzing historical and future trends of the marketplace. Research on the customers' unmet needs, problems, and benefits sought in the new product is performed and lead users are involved in the process.
- *Scoping*: where initial and rough research of the project is performed concerning market, technology, business and financials. Preceding this stage, a sorting through the ideas has been carried out to focus on determining which ones are worthy of more time and money.

- *Building the Business Case*: where a more detailed research is performed concerning competition, market, technology, manufacturing, testing, business and financials. This research results in a product and project definition, project justification, and a project plan.
- *Development*: where the detailed design and the operation and production processes are developed. The business plan is translated into deliverables and a prototype product is developed and partially tested.
- *Testing and Validation*: where final tests and validation of the entire project is performed including the new product, its operation and production processes and marketing. Customer usage tests and trial or pilot production are carried out.
- *Launch*: where commercialization of the new product is performed, including a thorough financial analysis concerning marketing costs, sales volumes, final prices and profit margins.

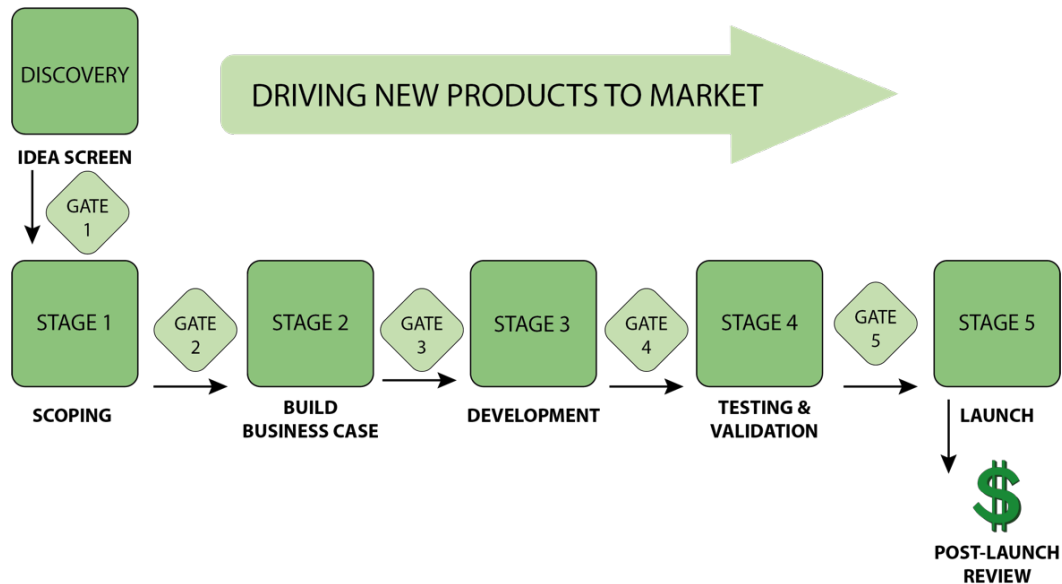


Figure 2: The Stage-Gate model by Cooper (2001).

According to Cooper (2001) the stages of Discovery, Scoping and Building a business case of the Stage-Gate process are considered to form the “fuzzy-front-end” which precede the actual development of a new product and where focus is to develop concepts and an action plan for the business case. Monsef and Ismail (2012) argue that to develop a successful idea during this phase several different actors must be involved, such as suppliers, customers, competitors, other industries and employees.

In the Stage-Gate process Cooper (2001) states that following each stage is a go/kill decision point where the gatekeepers, often people who are part of the senior management, decide based on the deliverables presented and preset criteria if the project should proceed or be killed. He identifies that if the project is decided to proceed the output of the gate will be an action plan for the upcoming stage and new deliverables. For each stage the project enters Cooper (2001) argues that the stakes and costs are increasing and it is therefore of importance to solely proceed with projects

that are promising and value-adding to the company. This makes the go/kill decision points very important to any project or company and it is of high importance that these points are well executed during the process. Considering the importance of these decision points these should have a clear existence within the product development processes of any company and should therefore be possible to identify and locate within the study.

Cooper (2008) argues that although the Stage-Gate process is well laid out none of the activities or deliverables are mandatory. He argues that it is simply a conceptual map for projects moving from idea to launch and can be modified to fit specific companies and projects. He further states that the Stage-Gate process in later years has been modified to making it more flexible, adaptive and scalable to enable continuous improvement and a fit for the majority of projects. Cooper (2008) claims it has further been developed to accommodate for open innovation in order to enable innovation ecosystems to be part of the whole process. By involving both open innovation and innovation ecosystems within the product development process it enables it to be more innovative than it already is. As it is defined in this study the view on innovation processes is well in line with the description of the Stage-Gate process as it takes an idea through the development process all the way to the launch of a product. A product development process using the Stage-Gate process as an outline is however limited to the innovation environment that its user has developed. By incorporating open innovation and innovation ecosystems the process becomes less restricted and enables for ideas and information to be spread both within the company and between actors within the innovation ecosystem and their surroundings. The concept and use of open innovation and innovation ecosystems are further discussed in chapter 2.1.2.

As the present market dynamics demands fast product development and that circumstances of the surrounding environment of a product and a company is constantly changing, companies are forced to work agile to stay relevant on the market. The SCRUM methodology is one of many methodologies following the characteristics of the agile way of working. It was first introduced as a development process adapted for software development (Schwaber, 1997). Schwaber (1997) defines a SCRUM methodology as distancing a product development process from for example the waterfall processes where stages and activities follow each other in sequences to a methodology where stages and activities are performed in iterations. This methodology enables for flexibility during the product development process which Schwaber (1997) considers to be highly unpredictable. More and more companies are adapting this agile way of working, resulting in a direct impact on the product development processes that they are using.

One version of the Stage-Gate process which takes this into account is one where Agile Development is incorporated, see Figure 3. Cooper (2008) describes this contribution to the Stage-Gate process to enable for markets which are fluid and need to be able to move rapidly. He argues that the Agile Development enables for the use of unstable information and for customer needs to be incorporated not only during the fuzzy-front-end of the process, but also as a contribution to the development and revision of the new product during the whole development. Cooper (2008) argues that by first studying the customers and understanding their needs and then having tests performed early in the process where customers can have a feel for the product by the use of virtual prototypes and hand-made models, the developers can collect early feedback to direct the

development. He states that in the Development stage more advanced tests can be performed involving a more complete version of the product and enable the developers to revise the product and evolve it to better fit the customer's ideal. Cooper (2008) argues that this version of the Stage-Gate process therefore enables for more feedback from tests and the opportunity to revise the product in a series of iterations all through the process. This should enable companies to be more flexible during the product development process and to comprehend the uncertainties of both the present market and future circumstances.

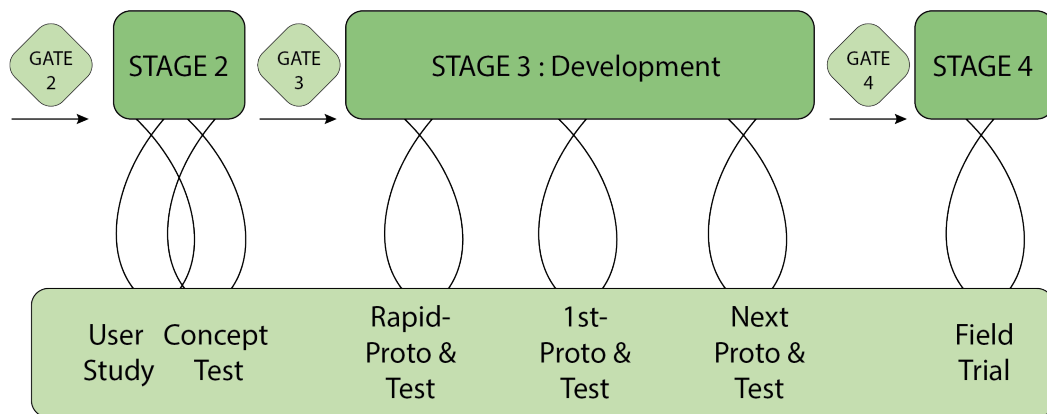


Figure 3: A modified version of the Stage-Gate model where Agile Development is incorporated to enable more tests and revision during the process, based on Cooper (2008).

2.1.2.Organizational Aspects That Influences the Innovation Process

The theories presented in this section circles around the environment of a company and how knowledge within the organization can be attained, shared and developed to enable better products. By understanding and connecting aspects of these theories, companies can adapt and continue to evolve and survive in an uncertain market.

Company Internal Knowledge Sharing

How knowledge is created is a central part of the innovation process and according to Nonaka (1994) there are two types of knowledge, tacit knowledge and explicit knowledge as well as the transformation in between. Smith (2001) explains explicit knowledge as such that can be conveyed in a formal and systematic language, while tacit knowledge is more subjective and acquired by personal experience. Polanyi (1966) who has been attributed the term of tacit knowledge argues that we possess more knowledge than we can mediate and that the knowledge that cannot be expressed in words is much greater than we think. Nonaka *et al.* (2000) argue this type of knowledge has a personal connection which makes it difficult to formulate and communicate. Knowledge is an important aspect within innovation processes and the ability of spreading it within the organization is equally important. Given the aspects of tacit and explicit knowledge being shared under different circumstances, these circumstances are important for a company to be aware of in order to make use of knowledge which is available within the organization during the innovation processes.

According to Day and Schoemaker (2000) the different kinds of knowledge, accompanied by many different sources of information in our surroundings, can be hard to interpret and contribute to noise and confusion. They believe that for a company to absorb this information it needs to be communicated and discussed in order for it to transform into useful insights and actions. Day and Schoemaker (2000) argue that this requires a learning capacity that can be achieved through the characteristics of a company's culture. These should include that the organizational units are open to diverse viewpoints, willing to challenge deeply rooted assumptions and mental models as well as a constant experimentation that encourage "well-intentions" even if they may result in failures (Day and Schoemaker, 2000). In other words, in order to spread and make use of knowledge the culture of the company must allow for this to be possible. This must further be intensely encouraged to also enable the spread of knowledge within the company which according to Nonaka *et al.* (2000) is personally connected and tacit and which therefore is harder to pass on. During an innovation process this would suggest that knowledge and information must be spread between the different stages and departments involved in the process in order to both create knowledge and to develop a good product. These diverse viewpoints and experimentations can be specifically valuable during the fuzzy-front-end of the innovation process as this is where the process is least affected by failures and resources are invested based upon a trying and learning environment.

According to Cohen and Levinthal (1990) the ability to exploit and make use of external knowledge is another important component to succeed with innovation processes. They argue that the more prior related knowledge that a company has, the more new knowledge can be utilized and its value recognized. They call this a firm's absorptive capacity and suggests it to be an additional result coming from a company's investments in R&D. Cohen and Levinthal (1990) argue that the greater absorptive capacity a company has, the more attentive it is to emerging opportunities and new technical developments. This would suggest that investments that a company spends within R&D gives value not only in new products and innovation processes, but that they also enable for important knowledge to be created within the organization. This enables the company to develop its absorptive capacity and to enable it to make better use of external knowledge. This could further enhance the innovation process as employees involved in it are becoming more knowledgeable and becoming more skilled as the process evolves. However, according to Lindsay and Norman (1977) only being exposed to related knowledge is not enough. They argue that the intensity of the effort of processing new information is critical as the information makes more connections and the connections also become stronger the more the new information is processed, improving the company's absorptive capacity. This would suggest that new knowledge and information cannot simply be earned by investing in a company's absorptive capacity and absorbing it, but it must also be processed and incorporated within the organization and its innovation processes for the knowledge and information to be of use. This would suggest that during the fuzzy-front-end of projects, further knowledge can be created and processed to be absorbed and that failures at this point can be seen as possibilities of enhancing the absorptive capacity. By working agile in the innovation process the absorptive capacity can further be enhanced as the company has the opportunity to reevaluate as more knowledge is created during the process, creating a better adapted product in the end and a personal development of the company's employees.

Company Environment

Dahlander and Gann (2010) argue that for a company to acquire external knowledge it must engage with different kinds of partners. They believe a company cannot innovate in isolation but must create an openness to the external environment in order to stay competitively relevant. They argue that open innovation involves making knowledge and resources available for others in order to gain knowledge and resources in return. This approach enables companies to improve their absorptive capacity by knowledge gained from others while also spreading their own knowledge to enable for developed innovation within the industry or market and developing improve product development processes. According to Dahlander and Gann (2010) R&D is suggested to be a necessary complement to open innovation as it enables expertise and resources within a company, making it an attractive business partner. They believe that while open innovation involves the risk of intellectual property being exploited to the company's disadvantage, the advantages to be gained from adapting to open innovation are many and the level of openness must therefore be well evaluated. This implies that while there are many advantages of adapting to open innovation, companies must evaluate to what extent they will share their knowledge and information with other actors to not be exposed to the risk of having their intellectual property stolen. The companies must also evaluate at which stages of the innovation process to adapt open innovation. By adapting it to the fuzzy-front-end they would benefit from having outside input and knowledge to create more innovative ideas, at the same time this approach would be a greater risk for the intellectual property as this is the phase where companies explore and innovate the most. On the other hand, in the development phase the scope of the project is often already set, and information and knowledge gained from other actors here might not have a desired effect. Although, Chesbrough (2003) stresses that by adapting to open innovation in the innovation process the boundary between the internal and external environment of the company becomes more porous and innovation can move more easily between the two. He believes this enables the R&D process to be more integrated with the surrounding environment, see Figure 4, and enables for better and faster innovation both inside the company and on the market. The research part of his theory can be compared to the fuzzy-front-end discussed by Cooper (2001) and by applying an agile working method to both the research and the development phases these would be improved as the work can be iterated as new knowledge and information gained.

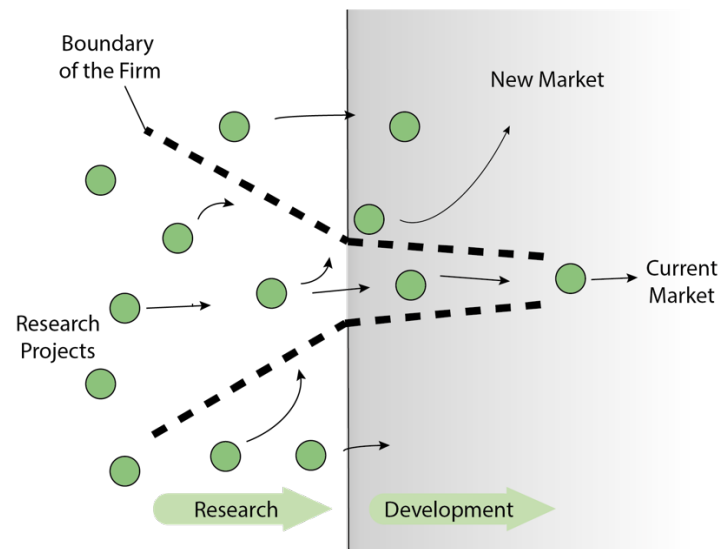


Figure 4: Visualization of open innovation during the R&D process, based on Chesbrough (2003).

Adner and Kapoor (2009) argue that an innovation cannot survive on its own, but must be supported by innovations of other actors within the company's environment to enable the use of the innovation. They argue that a focal firm often has a number of suppliers which are components in the upstream supply chain, but for the end-user to make full utilization of a product the focal firm must also have downstream complementors. According to Adner (2006) having an innovation first on the market is only successful if the partners of the supply chain are ready for the innovation and able to support it. These complementors can be for example as ink is a complement to enable the use of a printer. The printer is in this case of no value to the end-user without the ink being available on the market as well. The synergy that this interrelation creates is therefore suggested to be of great importance, thus valuable for companies to make use of open innovation to enable these synergies to be achieved.

Monsef and Ismail (2012) argue that vertical integration in an innovation process has been replaced by the use of networks of collaborators to enable open innovation in innovation projects. To coordinate this Adner (2006) argues that innovation ecosystems enable firms to create value through collaborative arrangements and combination of individual offerings, thus creating a value network where open innovation and complementary strategies are essential for creating end-user value. This implies that innovation ecosystems allow collaborating firms to collectively change the industry or market and enable innovations to be combined and supported within the network, thus achieve a higher end-user value. By combining the forces of different actors these actors should collectively stand a better chance of being competitively relevant on the market and therefore holding a more secure prospect of the future. As stated previously by Monsef and Ismail (2012) the integration of many different actors during the fuzzy-front-end is important to enable successful ideas. Ritala *et al.* (2013) argue that new product development too has refocused towards a more collaborative value chain and open innovation to enable early integration and growth potential of the innovation ecosystem. This would suggest an integration of the two at an early stage of the innovation process to enable for the new product developed to achieve a high end-user value and a successful implementation on the market. Ritala *et al.* (2013) further found that involving competitors into the innovation ecosystem can be greatly beneficial to gain end-

users. They argue this can enable standardization by the use of open innovation from the focal firm and its competitors. This would suggest that by aligning with competitors the different actors have the opportunity to steer the industry or market in a direction which could be beneficial for each actor's security of relevance. This would also enable companies to join forces to steer the industry or market towards a state which could be beneficial for the environment or the community etc. By involving in an innovation ecosystem a company has the opportunity to improve the quality of its product as a result of more accessible competences and a better understanding of the product environment and attributes. The cooperation can enable a more flexible innovation process as suppliers and complementors are on the same path concerning the market approach of the product. To ensure that the actors are all on the same path the integration of both open innovation and innovation ecosystems should be involved already during the fuzzy-front-end before the development phase starts and the adjustments possible are more limited.

2.2. Futures Studies

Futures studies is an umbrella term describing different methods of systematically exploring the future and trying to understand possible future developments and variables. According to Berkhout and Hertin (2002) the main purpose of futures studies is to investigate trends and potential discontinuities and to inform decision makers. Duin (2006) claims the use of futures studies will enable decision making for the longer term based on the possible trends of developments concerning economic, technological, social and political aspects. Futures studies has existed in well over 60 years and consists of a plethora of methodologies that have been used for a vast array of applications (Sardar, 2010). Marien (2002) indicates futures-thinking can be found in government, business, religion and academia to name a few. Boiling down the concept of futures studies, that has been called a very fuzzy multi-field, it can be read that many futurists argue that the central core of futures studies is about the future of humanity in general, but it is far more abundant than that according to Marien (2002). Sardar (2010) has formulated four laws of futures studies which he considers to be:

1. Futures studies are wicked, which relate to the problems we face nowadays. They are complex, interconnected and contradictory whilst also embedded in a rapidly changing and uncertain environment.
2. Futures studies are MAD (Mutually Assured Diversity), which requires that diversity is assured, and states that it will thrive in any desired future.
3. Futures studies are skeptical, a natural consequence of the first two laws since they cannot be satisfying through a simple one-dimensional solution.
4. Futures studies are futureless, which should be interpreted in a technical and specific sense, meaning that since we cannot possess true knowledge of the future, the impact of future explorations can only be significantly assessed in the present.

2.2.1. Scenarios as Futures Studies

Scenarios is one type of futures research that has its roots in early systems thinking, which first and foremost was used for strategic analysis and security (Berkhout and Hertin, 2002). According to Jackson (2003) systems thinking incorporates many interrelated constituents and their behavior

over time within a larger context. Mietzner and Reger (2005) argue that traces of this thus can be found in futures studies and its baseline is also what distinguishes the methodology of scenarios, with their way of taking multiple futures into account and providing a holistic view rather than a linear way of thinking. However, according to Cuhls (2003) the first attempts of scenarios performed by a man called Herman Kahn entailed only one single possibility of the future. During time this evolved and Khan later became one of the top futurists, who initiated the paradigm shift within futures studies from forecasting to foresight (Mietzner and Reger, 2005). According to Cuhls (2003) the main difference between these two constructs is that the area to be forecasted needs to be known at the start of forecasting but that directions for the present are missing, while foresight allows for more flexibility and creativity to search for new directions. She claims foresight is more open to the integration of new ideas and can be used as an initial process to assess information about the future without creating a fixed plan, which she argues is yet another process referred to as planning. Mietzner and Reger (2005) argue that foresight incorporates a strong focus on the process perspective with the basic assumption that there is a range of possible futures. In contrast, the basic assumption of forecasts is that only one future can be predicted, if the forecast is performed accurately. As the future is uncertain and developments and trends can take either direction for the future, foresight with its view of several different possible futures should enable a better chance of coming closer to the actual future than ending up in the single future predicted by forecasting.

Mietzner and Reger (2005) state that the purpose of scenarios is to create narratives of different possible futures that provide multiple explanations and aim to take many perspectives into account when describing complex events. They believe that by building narratives around carefully constructed plots the scenarios themselves aim to give meaning for these events. Berkhout and Hertin (2002) states that scenarios are created using qualitative tools to visualize images of alternative futures which can be understood by a range of different individuals. Scenarios therefore follow a recognizable procedure which is highly interactive and imaginative and the results may be used to communicate the vision of the future to anyone affected by its meaning. This would enable the use of scenarios within companies to communicate the possible futures that the whole company is envisioning and forces can be combined to work towards these futures regardless of position within the organization. However, Berkhout and Hertin (2002) emphasizes that the scenarios must be carefully planned and structured for the insights and results generated to be implemented successfully within the organization. The use of scenarios may enable for a better reception within the organization as it creates the openness to a range of future developments. If the situation does not reflect any of the predicted possible futures it might still be an alternative understood from the start of the project.

According to Ratcliffe (2000) scenarios create a holistic view of the future and integrate images of its evolvement. Huss (1988) argues that it can further also be used to provide insights about cause-and-effect sequences. This would enable companies to look at their organization from a holistic view in terms of the future and map the causes and effects that different developments would have on their company, improving the prospects of a production of products which can withstand the future. This is further supported by Börjeson *et al.* (2006) who claim that by using scenarios the actor can develop flexible strategies to withstand possible future developments.

Mietzner and Reger (2005 p. 233) describe that the majority of researchers in the field seem to agree that “*the idea behind this construct is to establish future planning which can minimise surprises and broaden the span of managers’ thinking about different possibilities*”. Their extensive analysis regarding the advantages and disadvantages of scenario approaches suggest that scenarios have the chance to offer more and get improved if combined with other futures studies, such as creativity techniques (Mietzner and Reger, 2005). This could suggest that the use of scenarios would be well suited to incorporate where companies are conducting creativity activities within their processes.

2.2.2.Scenario Classification

A commonly used classification of scenarios is one made by Amara (1981 in Börjeson *et al.*, 2006) which uses the classification of possible, probable and/or preferable for future scenarios. Building further on these Börjeson *et al.* (2006) identifies the categories of Predictive, Explorative and Normative scenarios and six different subtypes, see Figure 5. However, Mietzner and Reger (2005) disagree with this classification and argue that scenarios are either exploratory or normative, classifying the Predictive scenarios as forecasts rather than foresights and visioning the future which is the intent of scenarios. Börjeson *et al.* (2006) further states that the Predictive scenarios answer the question of *What will happen?* and focus on the present. Therefore, it can be argued that scenarios are a better fit for the two latter classifications of Explorative and Normative and that the Predictive scenarios are what would be defined as forecasting rather than foresights. However, Godet and Roubleat (1996) argue that the results of forecasts can be presented in the narratives of scenarios in a relevant and consistent way. This would indicate that the forecasts produced in the classification of Predictive scenarios could still be of use to enable the development of scenarios for the classifications of Explorative and Normative scenarios.

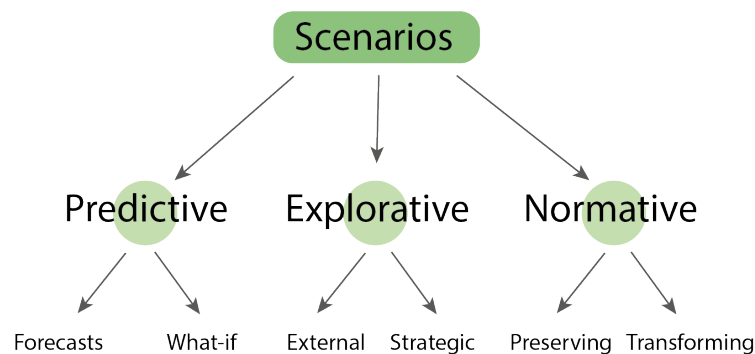


Figure 5: Scenarios classification based on Börjeson *et al.* (2006).

Explorative scenarios, explicated by Börjeson *et al.* (2006), are developed with their starting point in the future and answers the question of *What can happen?*. This scenario typology is mostly used within companies and organizations and is of best use for strategic issues concerning what is possible to happen. Börjeson *et al.* (2006) has further divided the Explorative scenario typology into External and Strategic scenarios. The External scenarios consider the external factors for the actor, while Strategic scenarios enables flexible solutions based on internal factors as the actor’s influence on external factors is limited.

Börjeson *et al.* (2006) describe the Normative scenarios as developed with their starting point in the normative and is further divided into Preserving and Transforming scenarios. This scenario typology answers the question of *How can a specific target be reached?*. The Preserving scenarios are a way of examining how a specific target can be met in the most efficient way by making small adjustments, while Transforming scenarios conclude a target which might seem impossible to reach and evaluate more radical changes needed to reach the target (Börjeson *et al.*, 2006).

Berkhout and Hertin (2002) claim that exploratory scenarios have their starting point in past trends while normative scenarios are visions of the future. This does not match the definition of Explorative scenarios starting point as defined by Börjeson *et al.* (2006) although the definition made by Berkhout and Hertin (2002) does not rule out the purpose suggested with these studies. Furthermore, Berkhout and Hertin (2002) claim that normative scenarios also can be referred to as Backcasting and which according to Robinson (2003) is an approach where different normative scenarios are developed to achieve certain long-term future states. Börjeson *et al.* (2006) refers to Backcasting as a method rather than a classification and that it can be used for Normative scenarios, but that other methods like workshops and surveys are also applicable during this scenario typology. The views of Börjeson *et al.* (2006) and Berkhout and Hertin (2002) concerning Explorative and Normative scenarios are to some part conflicting, but as the classification made by Börjeson *et al.* (2006) is well built on the classification of Amara's pioneering work this is the classification that will be considered during this study.

According to Mendoza *et al.* (2017) the Backcasting method is used as a top-down strategic tool and is carried out in six steps leading up to a business strategy plan of how to work towards this future state. This method can therefore be used as a way of describing the process of going backwards from the different possible future scenarios produced to the present. It presents a way to map out possible paths for the company to take in order to reach the possible futures from the position that they are presently in. According to Mendoza *et al.* (2017) Backcasting is often combined with Explorative scenarios of foresight as described by Börjeson *et al.* (2006). This would therefore enable an approach of using Explorative scenarios to envision the future and then applying the Backcasting method to draw the path from the possible futures to the present situation. According to Bishop *et al.* (2007) one advantage of Backcasting is that the future states defined are not based on the past or present, enabling a more open view of the future. However, Börjeson *et al.* (2006) points out that the disadvantage with Backcasting is that it can be expensive in the short-term of decision making and that while the focus with the method is to satisfy long-term targets these might change before the imagined future is reached.

Figure 6 visualizes the subject areas and their branching within futures studies that this study treats. Futures studies and its broad multi-field has been clustered to forecast and foresight, where forecast is of the predictive nature whilst foresight opens for many possibilities and is more accepting to the fact that the future is uncertain. Therefore, the foresight field examines both possible and preferable future environments.

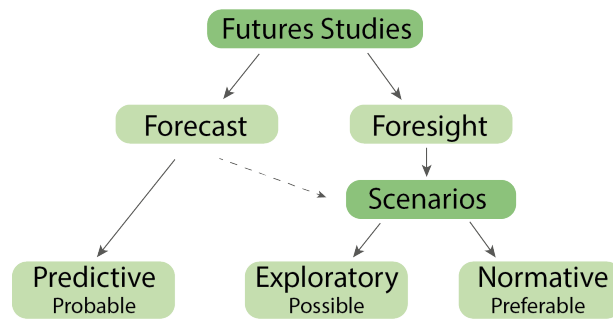


Figure 6: A visualization of the divisions of futures studies as viewed in this study.

The scenario technique is only one of many methods that would fit under this division, others can be trend-analysis and roadmapping to name a few. Since a version of a scenario method already exists within the recommended activities of the Stage-Gate process (Cooper, 2008) it implies that employees from the innovation process are already familiar with similar approaches. Moreover, the creative and holistic view required for scenarios corresponds with the mindset of innovators. Mintzberg (1994 in Drew, 2006) further points out that criticism on strategic planning is due to stifling innovation and its lack of creativity. Including employees from the innovation processes in activities that historically has been aimed for strategic planning could be a way of managing Mintzberg's (1994 in Drew, 2006) criticism and improve the outcome of the scenario activity. Therefore, scenarios possess the possibility to be integrated in innovation processes and improve them which argues for why scenario methods will obtain the focus of this study.

2.2.3. The Practice of Scenario Methods

The extent to which a scenario method can be executed may vary and the amount of tools used can differ. A tool as defined by Duin (2006) is an instrument used by companies as a means to carry out a method. Generally, scenarios are of the qualitative nature even though it can consist or be built around quantitative information and tools (Duin, 2006). However, Duin (2006) argues that the process of a scenario method should follow the outline of a process shared by many futures researchers. He argues that futures studies should be incorporated in processes of different kinds and that the studies should consist of three different stages: pre foresight, main foresight and post foresight. Duin (2006) presents what activities these stages could include, as a guide for good practice of a scenario method:

Pre foresight/input stage:

- Interview a variety of people with different expertise both inside and outside of the company
- Perform desk research (literature study)
- Determine the time horizon for the best fit, by determining the moment at which there is too much uncertainty to produce a reliable forecast
- Manifest a broad support of the scenarios in the organization

Main foresight/throughput stage:

- Perform interactive workshop to collect opinions and information from stakeholders
- Pay attention to that the scenarios should represent different endings as well as roadmaps that show the evolution of specific trends in various possible futures
- Pay attention to the visualization and communication of the scenarios
- Link the scenarios to the decision-making process
- Implement the scenarios in the organization

Post foresight/output stage:

- The number of scenarios is four
- The scenarios are explained with enough details for the ones that were not involved in the scenarios session to understand them
- The scenarios are made both recognizable and challenging for the users
- The scenarios are if necessary modified to reflect specific interests of the organization

Van't Klooster and van Asselt (2005) describe a method called scenario axes which is developed as a tool for constructing images of the future during a set of workshops. They argue that the method involves scenario participants to identify the two most important drivers for the future. They further state that the drivers chosen should be the ones that indicate the most uncertainty and impact and that these should then be plotted as two axes, see Figure 7. The most important drivers should, according to them, be supported by stakeholders and users to achieve consent and improve the scenario activity. Van't Klooster and van Asselt (2005) describe that as the two main drivers are chosen the participants are divided into smaller groups who each work with one of the four scenario quadrants as seen in Figure 7. They state that the aim is for the participants to develop ideas of future developments and story lines regarding the position on the scenario axes.

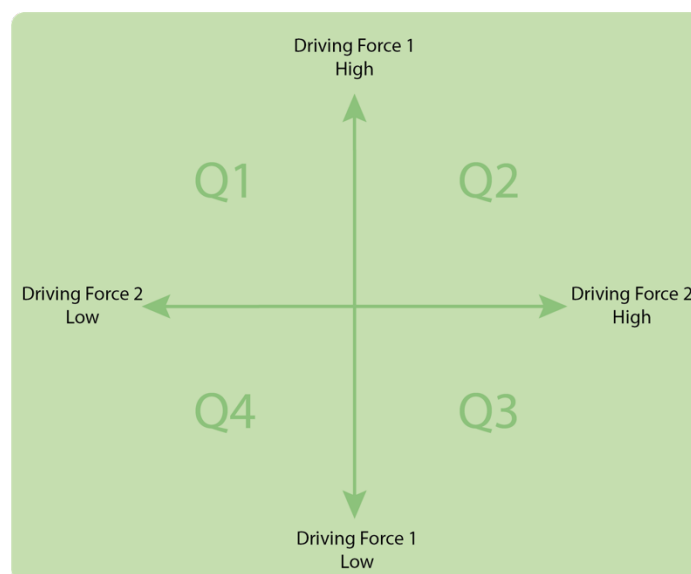


Figure 7: The main driving forces and the scenario quadrants of the scenario axes method by van't Klooster and van Asselt (2005).

Ratcliffe (2000) considers the scenario axes to be used as a tool for ranking and evaluating the scenarios developed rather than operating as a structure during the process of generating the scenarios. He believes the use of the scenario axes method can help determine which scenarios are most important and most uncertain and therefore should be catered for, with aspect to the two main drivers selected by the participants of the method. This way the creativity during the development of scenarios is not limited by the two drivers set and the scenario axes method can instead be used to determine which scenarios are most relevant to develop a plan for.

According to Berkhout and Hertin (2002) formal approaches to futures studies would include methods like cross-impact analysis, Delphi and expert consensus methods, while less formal approaches would include workshops and conferences. They claim an initial workshop should be at least a full day and they have formed a structure for this initial workshop which they claim should involve the following steps:

1. State the purpose of the workshop
2. Introduce the scenario method
3. Present the scenarios to be considered
4. Divide the group into smaller groups who can concentrate on part of the main topic
5. Provide feedback
6. Plan for when the next steps should be put into action

The three stages by Duin (2006) presents activities which should occur before, during and after the scenarios are developed. The Pre foresight/input stage which involves for example desk research could be viewed as the creation of forecasts to be used in the foresight as well as analyses of implications for future developments. For the foresight and process of developing scenarios, which would conform with the Main foresight/throughput stage of Duin's (2006) three stages, Berkhout and Hertin's (2002) workshop can be used. In addition to the activities proposed by Berkhout and Hertin's (2002) the axes method of van't Klooster and van Asselt (2005) can be incorporated between step two and three in order to develop the scenarios that should be elaborated during step four of the workshop. The participants will thereby start by deciding upon the two main drivers which will affect the future and thereafter decide on the four scenarios to be elaborated in smaller groups. The Post foresight/output stage of Duin's (2006) three stages involves communicating the scenarios further within the organization which is of high importance in order to capture the value of the scenarios developed. This process can be visualized as presented in Figure 8, which conforms well with the three stages presented by Duin (2006).



Figure 8: A visualization of the main stages that should be involved when developing scenarios.

2.3. Foresight in Innovation Processes

Both innovation and futures studies are of high importance to a company's success, and according to Duin (2006) innovation has been widely linked to the concept of the future. He claims an innovation process is characterized by high levels of uncertainty, and companies tend to overestimate the level of flexibility of the innovator to adapt necessary changes during the development process. Duin (2006) argues that throughout the innovation process there are many factors that can reshape the concept of the initial idea. He believes the idea and development of an innovation does not necessarily imply a market success of the innovation as many things can occur along the way that can influence the process. For example, he states that an idea which from the start was not technologically feasible can grow into a technological concept if it can benefit from new technological developments. He argues this causes discontinuities within R&D and innovation processes and extends the lead time of the development process. Duin (2006) further claims that futures studies can present a way to address this disadvantage, presenting a clear linkage between futures studies and innovation processes. He argues futures studies can prevent companies from investing time and resources in developing ideas that do not possess the potential of leading to a successful implementation on the market in the future. Duin (2006) explains that innovators collect information and perform analyses at various stages during the innovation process about how the product eventually will look and be used when finally introduced to the market. This suggests that futures studies present a way for companies to focus their investments and that the studies can function as a tool in regard of evaluating the relevance of projects. By having analyses and evaluations performed during the innovation process futures studies could be a continuous element which would enable the innovation process to change if the outlook on possible futures change during the process. Moreover, Duin (2006) believes that the introduction of an innovation on the market does not mean the end of its development process. He states that the way it gets embedded in society can go through many transaction and adjustments, leaving the innovation to look different from when it first was introduced.

Twiss (1992) describes that the innovation process incorporates high levels of uncertainty of which two can be outlined as the uncertainty of an innovation itself and the uncertainty of the future environment into which it eventually will be launched. Duin (2006) believes futures studies can make companies aware of the possible evolutions of external and internal factors and provide the organizations with an overview of possible effects of certain developments. He argues they can help companies with their ability to recognize and thus coping with elements of uncertainty. This line of argument is supported with the view of possible advantages that Mietzner and Reger (2005) presents in their study, proposing that if companies were to use futures studies within their innovation processes they would be able to adapt better to the uncertainty of future developments.

Drew (2006) argues that in order for companies to survive in unpredictable and fast growing or declining markets it is crucial with strong organizational capabilities. The criticism that Mintzberg (1994 in Drew, 2006) has directed to strategic departments lack of creativity and stifling innovation presents a mismatch with the innovative environment. However, according to Drew (2006) scenario techniques offer a way of incorporating creativity into the strategic planning process with its storytelling nature. He argues that through the process of scenario development, firms can

nurture and build creative and strategic thinking skills. He believes strategic innovation can thrive through the use of scenarios and their capability to improve foresight, knowledge absorption and management, creative and strategic thinking, flexible decision making and planning and future directed leadership. Although scenario activities are of relevance for the strategic planning the focus of this study will concern the product development process and the strategic aspects will therefore not be examined in further detail.

The main finding of Drew's (2006) research is that when analyzing disruptive innovations the application of scenario techniques can be successful. However, he believes that the development trajectories of disruptive technology are hard to predict and that the current managerial mindset is not yet fit for these disruptive technologies. In line with this, Duin (2006) argues that the scenario methods fit radical innovations better. He further believes that the uncertainty when innovating for radical change implies that more aspects need to be considered and therefore futures studies should address multiple aspects. Since the basis of scenario methodology is to incorporate several views and cover many aspects, it resonates with the uncertainty presented by radical and disruptive innovation, thus suitable as an investigative tool.

2.3.1. Application of Foresight in Innovation Processes

Rohrbeck and Gemünden (2011) have identified ways in which foresight activities can enhance the innovation capacity with regard to an innovation process, see Figure 9. They argue that the placement of the activity influences the impact on the innovation. The three placements that they suggest of foresight activities are: initiating role, (in the beginning of the innovation process), the opponent role (alongside the innovation process) or the strategic role (outside of the innovation process).

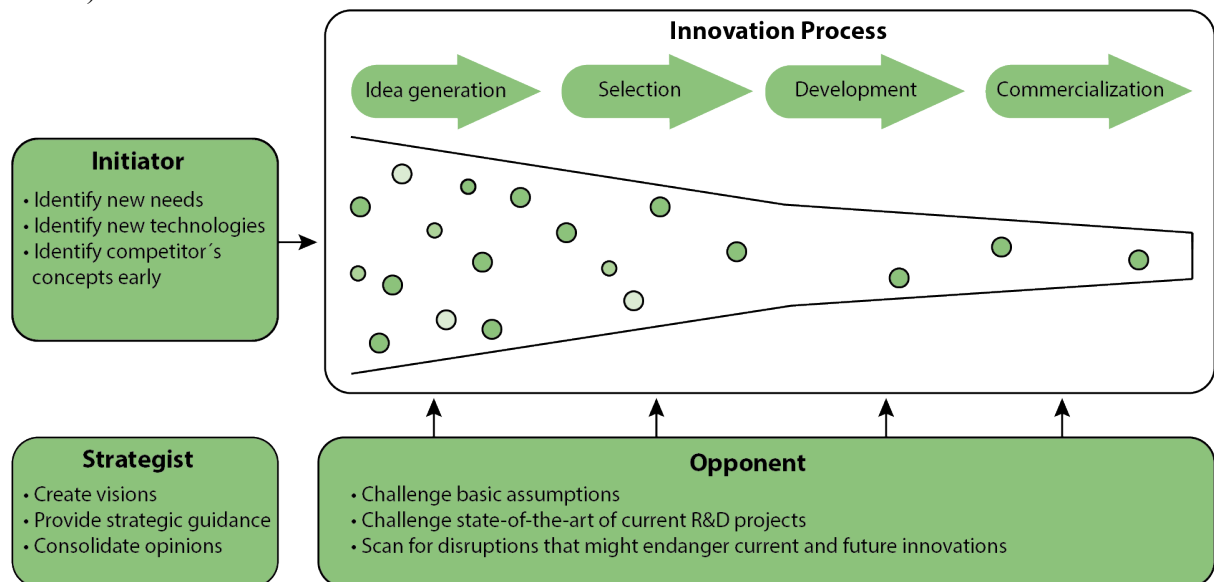


Figure 9: Three ways of enhancing the innovation capacity during an innovation process presented by Rohrbeck and Gemünden (2011).

According to Rohrbeck and Gemünden (2011) the initiator role triggers innovation initiatives and can be of value for new R&D projects or business-model innovations. They believe that by using foresight in the introducing state, feeding directly into the innovation process, the quantity and

quality of the innovation outputs increase. Rohrbeck and Gemünden (2011) also state that the three most impactful identifications that can be achieved with the initiator role is: new needs and customer requirements, emerging technologies and new competitor concepts. The respondents of their study have noted that when dealing with new business fields and in times of discontinuous change the initiator role is crucial. This would further support the use of scenario methods in the beginning of the product development phase, previously referred to as the fuzzy-front-end. As discussed by Cooper (2001) this is where new ideas are generated and this should also suggest that the use of scenario methods would help to screen and choose the ideas with the most prospect for the future.

The opponent role primarily presents a chance to challenge the basic assumptions of the innovation, leading the innovators to create better and more successful innovations according to Rohrbeck and Gemünden (2011). With its impact throughout the innovation process they believe it also ensures the current *state-of-the-art R&D projects* and if these need to be refocused. Typically, Rohrbeck and Gemünden (2011) argue that the activities are based on worldviews that are not established in the company but that are existent outside the company's environment. They believe that by incorporating this they have the chance to explore the disruptive potential of an innovation and scan areas that would otherwise be unobserved. This role would enable the company to make sure that they are focusing on projects which are relevant for the future not only in the perspective of the company's future but also the environment in which the innovation will be launched. This role should therefore be of great importance to ensure that investments are made in the best way regarding the future of the company. The part of the company working with this role of foresight would perhaps benefit from being part of an innovation ecosystem where outlooks of the future could be shared by all the actors involved in the network. This would facilitate creating worldviews not solely based on the company's standpoint, hence match Rohrbeck and Gemünden (2011) arguments that the opponent should be based on worldviews existing outside of the company's environment.

The strategic role as described by Rohrbeck and Gemünden (2011) can direct the innovation strategy by creating a vision and a common understanding of the future and consolidate opinions throughout the company. According to them this role is not directly linked to the innovation process; however, it contributes to providing strategic guidance and handling the innovation portfolios assessment and repositioning. Rohrbeck and Gemünden's (2011) study shows that most companies that use the strategic role have a differentiated department aimed for management of strategic innovation and/or technology. Rohrbeck and Gemünden's (2011) are encouraging involving the members of these teams in foresight activities conducted in other parts of the firm. By incorporating these teams in the foresight activities, the strategic planning for the company will be infused by the possible futures that the company envisions and the whole company will have a more united view of future developments and how to embrace them. By the use of scenario techniques as discussed by Drew (2006) this would enable the strategic role to better communicate their strategic planning by using this storytelling method and it would further enhance their creativity and innovation.

Likewise, Duin (2006) addresses the vital role of the future researchers and the innovators and emphasizes the human activity. From his case studies he found that there is either a lack of process or a lack of content in the outcome of foresight activities, which he believes would imply that most commonly the futures researchers are providers of process skills and the innovators bring knowledge and information. This suggests that it should be essential not to rely on one individual and that collaboration between people with different views and expertise is necessary for reaching a good quality foresight that can be integrated in the innovation processes.

2.3.2. Incorporating Foresight in Innovation Processes

As seen in Duin's (2006) case studies, the most common placement of futures studies in companies with regard to their innovation process is in early stages. He argues that in that manner the futures studies aim to generate new ideas for innovations and inspire innovators. During the Discovery stage of the Stage-Gate process described by Cooper (2001) the use of scenarios is suggested which should further indicate that during this stage of the product development process it would be appropriate to implement the use of scenario activities. The Stage-Gate process suggests that these activities should incorporate a study of historical events and future trends of the current marketplace for the product. However, as discussed by Duin (2006) futures studies should incorporate an even bigger spectrum of aspects of the surrounding environment in order to be successful. This suggests that the view that the Stage-Gate process gives might be limited in its perspective and a more holistic view of the environment surrounding both the product and the company is needed. This much resembles the way Rohrbeck and Gemünden (2011) view the initiator role where the early placement intends to create an awareness as well as showing promising directions. Based on Duin's (2006) findings and conclusions he suggests a basic theoretical framework, see Figure 10, that represent the iterative use of futures studies in innovation processes.

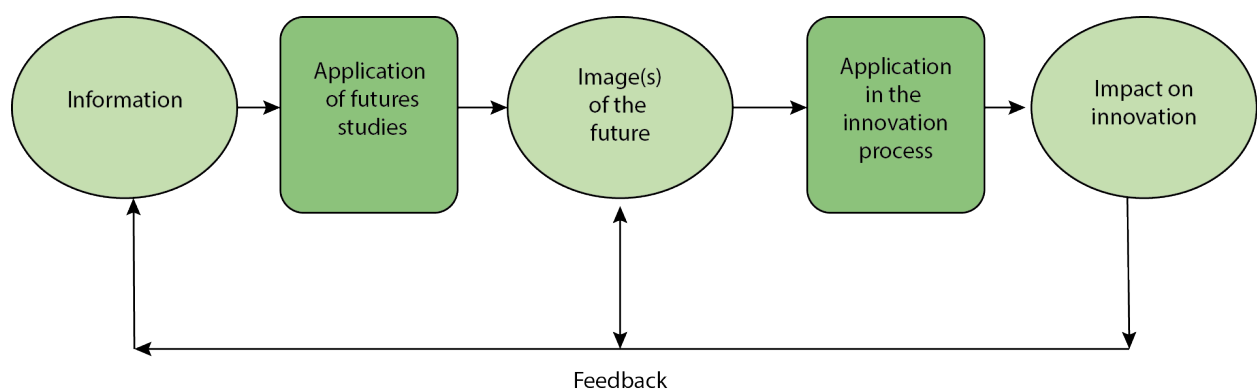


Figure 10: Duin's (2006) basic theoretical framework for the use of futures studies in innovation processes.

The boxes in Figure 10 are processes and the circles are the outcome of a process. According to Duin (2006) information about the future development is gathered through various channels (interviews, desk research, workshops etc.). He states that the information is structured and analyzed by conducting a method for futures studies, for example scenarios, which generates images of the future. According to Duin (2006) it is these images of the future that are implemented in the innovation projects and should imply an effect on the idea selection with regard to the

innovation. He claims that the impacts and results regarding the innovation feeds back in the framework and influences the following developments of images of the future as well as providing information of new possible applications of futures research (Duin, 2006). The three first steps, one process and two outcomes, of this framework would indicate a use of futures studies and the images that is the outcome of this first process resembles to the images of possible future scenarios produces during scenario methods. As the activity of futures studies can be applicable during the whole innovation process as discussed in the different roles by Rohrbeck and Gemünden (2011) this activity could occur at any time during the innovation process. However, its first occurrence should be during the fuzzy-front-end of the development as previously discussed since this phase initiates upcoming projects within the company. This suggests that the second process of this framework, the application in the innovation process, could occur during any time in the innovation process and this would then have a direct impact on the product development process and the stage it is currently in.

According to Duin (2006) a dilemma concerning the use of futures studies within companies is that when business is good companies tend to focus on trying to satisfy the short-term customer needs, leaving little time for futures studies. Furthermore, he argues that when business is bad the scarce financial resources hamper the attention on futures studies as the main priority is to keep afloat. This leaves futures studies in many cases confined to very few opportunities of use within companies. As this study shows, there is opportunity for companies to involve futures studies within their innovation processes in order to stay relevant in an uncertain and fast growing or declining market and to prepare for future developments. By using scenario methods the vision of the possible futures that is facing the company can be conveyed all through the company and make sure that not only the strategic plan but also the vision within the company is in line with these futures. The real challenge is to convince companies that the use of futures studies is worth investing in at all times and that they should not be disregarded when business is good or bad.

2.4. Analytical Framework

Presented below in Figure 11 is the analytical framework which explains the connections between the different theories introduced. The main purpose of the analytical framework is to give an understanding of what parts within the companies examined that needs to be available in order for a successful implementation of scenario activities in the innovation processes. The two main parts and their interconnections are described below as well as the merge of scenario methods and innovation processes.

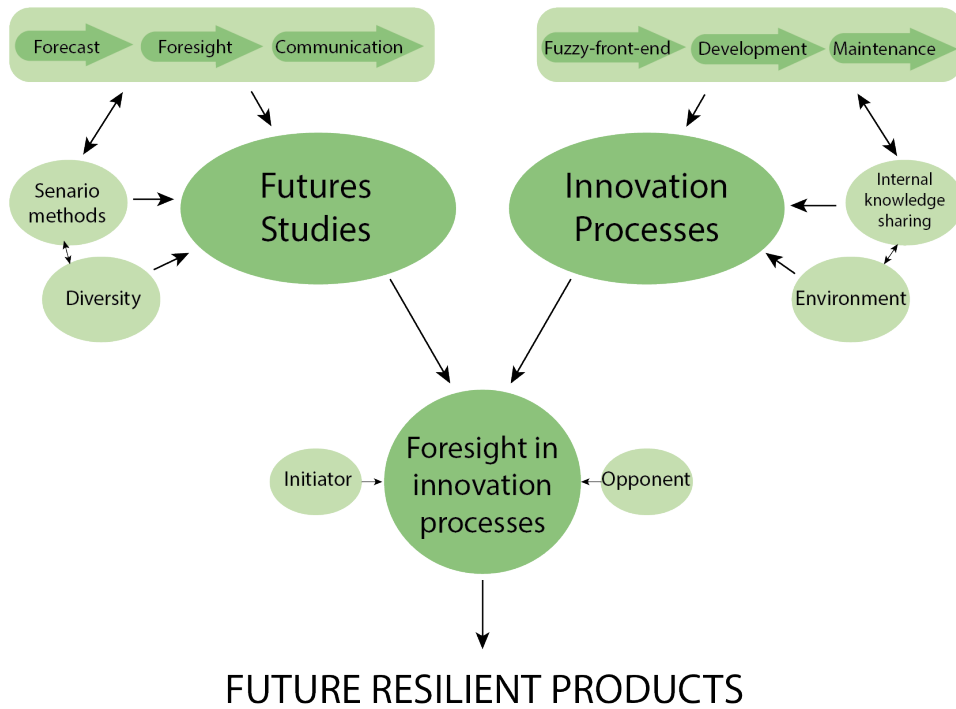


Figure 11: Visualization of this thesis analytical framework.

2.4.1. Innovation Processes

By viewing the generic product development process by Eppinger and Ulrich (2012) and the different Stage-Gate processes by Cooper (2001, 2008) the product development process seems to have two phases which are key to the development of a product and relevant in the merge with futures studies. The phases are the fuzzy-front-end phase and the development phase. A phase called maintenance has been added referring to the activities occurring after the launch of the product. As Duin (2006) argues the product will go through many adjustments after it is introduced to the market and the development of the innovation does not end with the launch. In accordance with what Schwaber (1997) and Cooper (2008) state these phases need to involve iterations to address the rapid growth and uncertainty of markets and enable for changes as the environment of the product changes.

Both the company's internal knowledge sharing, and environment are important aspects for the innovation. A more efficient innovation process can be enabled through the use of open innovation discussed by Dahlander and Gann (2010) in combination with an innovation ecosystem discussed by Adner (2006) to exchange information and knowledge to strengthen the relationship between the actors. By interacting with the external environment, the company's absorptive capacity and knowledge creation can be further improved as the company will receive new knowledge through the innovation ecosystem. Hence, the internal knowledge sharing plays a crucial role to align the different departments of the company.

2.4.2. Futures Studies

The value of scenario methods is created through the processes of forecast and foresight. As discussed by Godet and Roubleat (1996) the forecast activities can contribute with results and numbers of occurring trends which can be used as input to the foresight. By applying results of predictive calculations in the foresight this can contribute with a greater trust for the scenarios developed, thus having a better chance of being accepted within the company. To capture the value that is created through forecast and foresight the results need to be well communicated throughout the whole organization. To enhance the quality of the scenario method a diversity among the participants is needed as discussed by Duin (2006). This diversity will contribute to a broad knowledge basis and different mental models being applied to the scenarios. By having a diversity of competences and outlooks the scenarios developed will be susceptible for all participants and as a result also a larger part of the employees of the company. The larger the diversity of the participants the greater holistic perspective can be obtained.

2.4.3. Foresight in Innovation Processes

The use of foresight activities during the innovation process will enable more flexibility as the company is aware of different possible futures. Using scenario methods during different phases of the innovation process can enable for a better understanding of what environment the product will finally be launched in and an opportunity to continuously reevaluate the product and adapt the process accordingly. Incorporating scenario methods as the initiator role, described by Rohrbeck and Gemünden (2011), in the fuzzy-front-end can contribute to both a higher quality and quantity of ideas for new concepts. Further using the results of scenario methods as the opponent role, also described by Rohrbeck and Gemünden (2011), will be of value for adjustments throughout the whole innovation process as well as after the launch of the product. Through a good integration of scenario methods into innovation processes, it increases the chance of creating future resilient products by spreading the information within the company and to its decision makers.

The use of innovation ecosystems during a scenario method creates an environment with diversity as the participants are from different actors within the market or industry and create a holistic view which would enable for better scenarios to be developed. By further having a well-established internal knowledge sharing the results of a scenario activity can be well-received. This will facilitate the different departments within the company to understand their part in the scenarios produced as well as understanding how and with what other departments will contribute with.

3. Method

Presented below is a presentation of what theories the methodology of this study is based on. Then the process this study has undergone is explained in chronological accordance with the execution. Finally, a discussion about choices and execution including the validity and reliability of this study is presented.

3.1. Method Theory

This master thesis is based on a qualitative study that consists of a literature review and humanistic inquiry. Humanistic inquiry according to Hirschman (1986) implies a set of fundamental beliefs describing how the researcher views the world, entailing that human beings construct multiple realities and these should be viewed holistically. Since phenomenon arises in a continuous process it is not suiting to divide aspects into “causes” and “effects” (Hirschman, 1986). This standpoint will influence the study since researchers further act as the tool for collecting data. This approach was chosen to enable the desired result of finding how futures studies can be incorporated within innovation processes. Hirschman (1986) argues that humanistic methods are good for generating ideas, which is necessary for what this study aims to accomplish. The data collection tool of qualitative semi structured interviews was chosen for the investigation of the companies’ structure, activities and culture. A qualitative interview is characterized by simple and straightforward questions whereupon answers which in many cases are complex and rich in content is obtained, leaving the researcher with extensive material (Trots, 2010). Further, the semi structured form of interviews was chosen because it allows for follow up questions and contributes to increased understanding of people's perceptions, opinions and behaviors (Boeijen, 2014). Since researchers serves as the measuring instrument, and the fact that researchers’ understanding arises from personal experience and knowledge (Hirshman, 1986), the initiating literature review contributes to educating and preparing researchers for the interviews. The development, execution and processing of the interviews has followed the recommendations of Trots (2010).

3.2. Method Execution

Presented below is the process which the project has followed and the methods used throughout the study. Figure 12 illustrates the workflow of the process and presents the overlap of different activities.

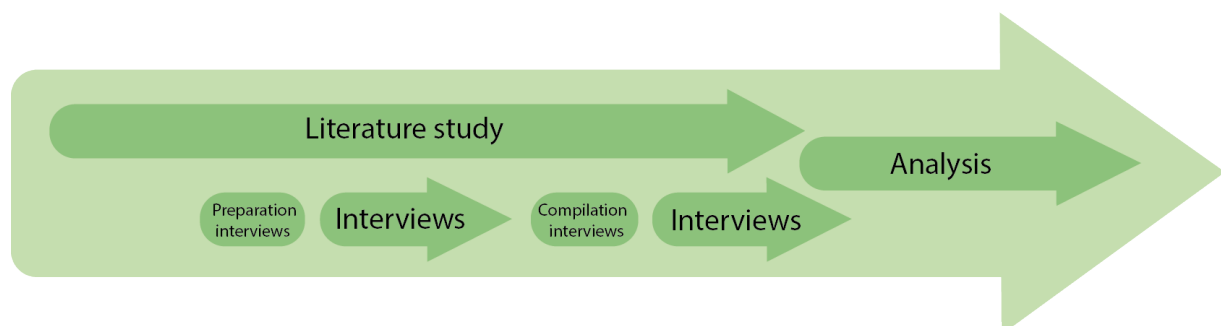


Figure 12: The process and its activities during the project.

3.2.1.Literature Review

Based on previous work and articles attained, the study started with a literature review concerning futures studies. A search was performed on the Scopus database using the keywords *scenarios*, *futures studies*, *futures research*, *forecast* and *foresight*. Following this a search for linkages between futures studies and innovation was conducted. This was performed by searching for keywords such as *innovation*, *innovation process(es)*, *futures studies*, *futures research*, *scenarios* and *foresight* in different combinations on the databases Scopus, Web of Science and Google Scholar. The aim of this search was to find the intermediate connections between innovation processes and futures studies to enable a more focused entry towards innovation. Afterwards, a further search was performed on Scopus, Web of Science and Google Scholar with the keywords *innovation process(es)*, *new product development* and *innovation ecosystem* to find further inputs to supplement the previous attained theory concerning this.

The theories discovered during the literature review were processed by linking the concepts together with the aim of creating an analytical framework. However, when reviewing the information gathered it was found that the literature linking futures studies and innovation commonly covers the strategic and managerial aspects of the innovation rather than the product development of new products. Therefore, yet another round of literature search was executed to expand on the literature review to further explore the academic perspective on the combination of foresight in innovation processes. The keywords *NPD*, *scenario*, *foresight*, *development process(es)* were used in the database Google Scholar. Furthermore, the reference lists of previously used articles were examined as well as an exploration of succeeding articles which referred to the articles already used in order to find more perspectives. The theories discovered during the literature review were connected and combined to form an analytical framework which would later be used to evaluate the empirical findings.

3.2.2.Interviews

Based on the theories and methods from the literature review an interview guide was formulated in order to facilitate the investigation of the innovation processes in the industry of rail and road vehicles, see Appendix 1. The aim of the interviews was to understand how organizations and innovation processes are structured and in which departments and in what aspects companies are using innovation and futures studies. The guide supported an interview of the semi structured nature that would allow room for discussion and follow-up questions. To test the interview guide a pilot interview was conducted with a person having a long history within the railway industry, thus possessing in-depth knowledge about innovation processes in vehicle development. To gather participants for the interviews people from the research center of a Swedish university were inquired. Contact was initiated through each company's representatives in the center during one of their gatherings. By presenting the scope of the study and a request for interviews with employees having an insight of the way the company is working with their innovation processes the representatives provided contact details for employees that could be of interest.

A first round of interviews was performed with five employees at three different companies. The companies are manufacturers of rail and road vehicles active in three different markets: cars, trucks

and trains. The interviewees possessed different roles within the companies, from strategic planning to design and product development. At the end of the interview all participants were asked if they had any recommendations of other employees with knowledge concerning the subjects discussed that could be willing to participate in an interview, leading to further contacts.

A compilation was made after conducting the first round of interviews and the findings were compared with the literature review, whereupon the information gathered from the different companies were compared against each other. By comparing the different interviews various gaps of information for each company was found and the perceptions of the organizations differed. These gaps influenced the adjustments of the interview guide and the decision to continue with two separate interview guides was taken. As an attempt to create a mutually extensive understanding of the different organizations the adjustments were based on information which needed to be completed and focused for the car company and the truck company, see Appendix 2 and Appendix 3.

A second round of interviews was conducted with employees who had been recommended in previous interviews. This round consisted solely of two out of the three investigated companies, those of cars and trucks, as no further recommendations of available employees were obtained from the train company. Table 1 presents the number of interviews from each company as well as the position of the interviewee.

Table 1: List of interviews and their distribution.

Company	Position	Interviews
Cars	Director New Technology	4
	Director Strategy	
	Team Leader Strategy, Creation & Innovation	
	Strategy and Concept, Exterior	
Trucks	Head of Strategic Product Planning Automation	4
	Design Engineer, Chassis Components	
	Research Director, Research & Innovation	
	Senior Manager	
Trains	Former Acoustic Specialist	2
	Converter Electrical Engineer	
Total		10

Depending on the geographical location of the interviewees, the format of the interview varied. Two of the interviews were conducted in person at the company's site, one of the interviews were held over the phone and remaining interviews were conducted through video conference. One

interview was conducted in English, while the others were conducted in Swedish. Besides taking notes during the interview, they were all recorded, and the audio/video file was later processed. By listening to the interviews a second time the researchers were presented a chance to notice and reflect on details that were not observed during the interview. Transcripts of important aspects with regard to the purpose of the study was constructed for each interview, whilst listening to the audio/video file. The empirical findings from the interviews were then compiled and evaluated to find similarities and patterns within the obtained information.

3.2.3. Analysis

The transcripts from the interviews were processed by underlining paragraphs and quotations that carried a meaning. The underlines were color coded according to company and position. The underlined phrases were then collected in one document for each company with the purpose of easily separating the responses from the different companies. In this manner it was possible to detect trends and at the same time build an understanding of the different positions' responses to the questions. The underlined paragraphs were brought to a discussion session where the quotations were clustered into four groups. The following clusters were created: innovation process, futures studies, company internal knowledge sharing and company environment. These clusters acted as subchapters when formulating the empirical findings for the different companies whereupon each company's empirical findings were sent to the interviewees of each company to get revised and approved.

The empirical findings gathered through the interviews were then analyzed in comparison to the theories discovered during the literature review. The quotations that made up the clusters were revisited and further discussion sessions were held in iteration where the insights from the processed data were elaborated. Status quo and trends detected were evaluated and considered to enable a better and more efficient implementation of futures studies within innovation processes of manufacturing companies. These were used to compose recommendations on how to create and conduct a scenario method that can work in favor of all departments within a company and enable a product development which can withstand an uncertain future.

3.3. Method Discussion

By choosing a qualitative research, many risks are accepted. The semi structured interviews require participation of the interviewer and is influenced by his/her personal traits like empathy and intuition, thus leading to a subjective and biased outcome (Hirschman, 1986). However, since the situation investigated comprises of an environment where the human activity is crucial, the format of semi structured interviews is considered fitting. The use of the methodology of scenario activities is of the same nature, largely relying and depending on opinions and experiences of the people conducting them. Therefore, it can be argued that methodology for investigating the opportunities of extending the use of scenarios in companies should be coherent and aligned with the methodology of scenarios itself.

The content of the study has been developed by two persons who have worked with the material in parallel and examined everything carefully which has allowed for discussions of two different

interpretations of the situations and the concepts. Therefore, the reliability of the study should be considered good, despite the limitations presented by semi-structured interviews. There is indeed a lack of consistency, in that the interviews were performed in various environments as well as in various languages. The objectivity could be affected since the follow-up questions depended on the interviewee's knowledge and interests. However, the interview guides remained the same and was followed to a great extent during the two rounds of interviews. The doubts of consistency and objectivity has been compensated with high precision, as the interviews always were held by the same interviewer while the notes were taken by the other. Further, the content of the interviews has been collected through recordings and later processed in an equivalent way. Moreover, close collaboration with a supervisor from the university as well as a supervisor and a project owner from the company has been maintained throughout the study, where the material has been shared and discussed in iterations. This has allowed for guidance and additional perspective whenever encountered with any uncertainties.

The study has been conducted in a structured and systematic way in which the analysis has followed a recommended process. The concepts used have been well defined by the writers and translated into the interviews which strengthens the validity of the study. The extensive discussion about definitions has helped ensuring that the interview measured what it purports to be measuring. The limitations considering the validity of this study is that there is no concrete benchmark for validating one's interpretations, neither in principal nor with technical adjustments. By presenting the steps that the study has undergone and achieving high transparency regarding how the empirical findings have been processed the aim is to shed light on the process and contribute to the credibility of the study.

The analytical framework was created with the purpose of investigating manufacturers of vehicles and their innovation processes. Empirical findings from the interviews have inspired the design of the analytical framework which makes it customized for the innovation processes for companies in the industry of rail and road vehicles, although the intent was to identify characteristics for innovation processes in general as well. What characterizes the innovation processes of the industry of rail and road vehicles is that they are including high technology components, requires specialized competences and often lasts over a couple of years. However, the components in the analytical framework are important cornerstones for every innovation process, and it is believed that with slight adjustments, this framework presents a useful tool for investigation that would be fruitful for various companies aiming at staying flexible on a dynamic market and delivering future resilient products or services. The results of this study is therefore also generalizable for other companies and industries, specifically those that are also characterized by high technological components and which require specialized competences. All companies are affected by the dynamic markets and although the conclusions and recommendation of this study are developed and seem most suitable for industries with projects and developments that lasts over several years, they should be adaptable and fruitful for other industries' innovation processes within manufacturing as well. By adjusting the results, the findings of this study should further be adaptable even for industries providing services of different kind. This means that as intended, the findings of this study should be generalizable for a number of other industries and not only for the industry of rail and road vehicles.

One important matter to emphasize is that the number of interviews are fewer for the train company. As a result, the information collected has not treated their approach to future studies to the same extent. This may depend on the positions of the employees that have been successfully contacted. This may create a feeling of lack concerning future studies at the company, but that does not imply that their work is less legitimate only that it is something this study is not able to either confirm or reject. However, the information gathered from the train company has provided a better understanding of how innovation processes can differ and brought interesting perspectives from specialists in the innovation processes. This has widened the spectra of application and is therefore included in the study.

4. Empirical Findings

Presented below is the empirical data collected through 10 different interviews. The interviews were conducted with three different manufacturing companies developing cars, trucks and trains. The first interviews followed the interview guide in Appendix 1 which was later configured (see Appendix 2 and Appendix 3) as the understanding of each company grew.

4.1. Innovation Processes

This section presents the empirical findings of the innovation processes of the investigated companies. It entails how the structure of the corresponding innovation process is divided and organized and how ideas arise within the company.

4.1.1. Company Cars

The car company has recently undergone a restructuring of their processes, moving from a sequential “waterfall” process to a more agile one. The new process is based on an agile framework with hierarchical influences which is suiting for the size of the company. Many of the aspects from the previous way of performing innovation are either lingering or preserved. One of which is the way the innovation process breaks down into four phases: pre-development, concept, industrialization and maintenance. The pre-development involves strategic planning and advanced engineering and all product streams work according to the following steps:

1. Identifying new need
2. Evaluating budget possibilities
3. Secure resources availability (project leader, function owner)
4. Develop project and conduct gate reports
5. Transferring the pre-development project to production project
6. Documenting all the information in a shared library

One of the interviewees says that for most products streams this process is still used as it is a guide that provides quality assurance even though the different projects can tweak and adapt it to their own context. An overall perception is that the importance of succeeding with a project grows along with the proceeding of the process. Failing in the pre-development is fine since the main motive of this phase is to verify how feasible a project is. The closer it gets to production the worse the consequences are if they have to shut down the project. Common for all teams in the company is that they work with 12-week increments. Every 12th week the teams go through what is to be delivered during the next increment and at the end of the increment they evaluate if the goal has been reached. The division of the time phases is made to facilitate the solution development as they usually have trouble finding and freezing all the interfaces that link the components together. Every team should preferably work in the same development phases. The division of the product streams and component teams is made because not everyone needs to be involved in all the parts. A team should offer their component for products that they have in their pipeline, so that projects come to an end when they put all the components together into one product. Through the structure of the process the components are constantly in the construction toolbox and the technical

capability of the component makes it possible to integrate them into a car, a project or a product.

One reason why the company wanted to adopt the agile way of working was that the market is not as predictable as before, when they could set strategies for almost 30 years ahead. One employee explains that at that time the waterfall process was suiting with its structured gates and controls, but in the present industry the digitalization makes implementation speed faster and therefore the company needs to work agile in order to keep up with the trends. The method tries to create value in short sprints while in a waterfall process the value is created at the end which poses a huge risk. In an agile system value creation can be seen and captured during each week of the innovation process. This also makes it possible to continue to develop the product after it has reached the production. The company has introduced a somewhat new business model with a subscription-based service, which allows them to create value in a product for 5-6 years. This means that they can make the product better even when it is sold. One of the employees speculates about a future where R&D also could be included in the maintenance phase, after product launch, as digitalization allows for continued development and refinement of the product.

The company's new process has empowered teams with the freedom and ability to create the best possible flow. To be able to do that, they must deal with all the dependencies, which is a challenge. Process and results have always been the main focus, but there is now less emphasis on reporting to management and more about moving it forward and finding a concept that works. One of the employees describes that this has on the one hand made the work more fluent in the separate teams, since management does not interrupt the flow by asking for presentations of their products as often as before. On the other hand, each team is responsible for their own backlog, which makes it more complicated to align the different product streams and deal with the dependencies.

There is a consensus amongst the interviewed employees regarding that ideas for new developments or directions can appear anywhere in the company. Many times they come from inside the processes when employees encounter problems. When good ideas arise, they try to channel them into one of their existing processes straight away.

The company has a decision forum where employees can hand in ideas. It usually varies how ready or well thought through the ideas are. One employee mentions that innovation teams tend to go directly to senior executives to ask permission to engage in new ideas. This rarely gets accepted as these managers prefer a decision produced basis regarding how to connect the new idea to their current practice. Therefore, they create a document which explains the relevance, scope, timeframe and limitations of a possible project to explore and develop the idea. In the decision forum they rank the ideas that come up based on, for example, business benefit or customer value. If the idea does not suit their customers and offers it can be transferred to one of the internal start-ups with the goal of getting a customer market fit, or one of their innovation hubs. The internal start-ups embark on new markets and thus do not endanger the core company if the idea poses a great risk but offers a potential value. If the idea is good but a solution of how to tackle it is lacking people can be gathered to solve the problem. Ideas that do not make it through get documented through a backlog.

The selection criteria that the company uses are working but they are not optimal according to some of the employees. The innovation and foresight function tries to make it clear that they should have total freedom up until the point where they need to either engage a larger proportion of employees or a larger budget. For the innovation and foresight function the management is prohibited from controlling or interfering with the team's ongoing work up until the moment that they want to expand the project. Within this function they approach new ideas with a process consisting of three steps: perception, practice and definition. The perception stage focuses on grasping the new area and finding the words to describe one's findings. It is usually created by the employees themselves but sometimes they need additional supporting information. The practice stage focuses on building concrete knowledge about the area since at this point they should be receptive of it. One of the employees explains that is important not to rush through these steps or skip anything, otherwise it can be misinterpreted and not received well. If this process is carried through correctly the definition of the problem is created by itself.

The formal and most common way ideas and directions reach the pre-development teams is through annual meetings where the attribute council explains what kind of areas they would like each team to embark on. The attribute council provides descriptions of what it could mean, whereupon each team discusses it internally before checking with their business owner who needs to approve it. Each team has their own selection criteria which is implemented if they are facing many choices that need to get prioritized. They need to make sure that they answer to the most urgent ones first.

4.1.1. Company Trucks

The truck company works with continuous improvements to components rather than major new releases, they perform platform lifts changing the structure of the product only every 15-20 years. The products the company produce are set up as modules with standardized interfaces making it possible to combine the different modules in several ways. That way they can adjust their assemblies to fit the customer requirements and letting the customer pay only for what they need, increasing the value of the product.

The company has a well-defined innovation process which the R&D department follows. The projects performed are managed through a project department which is responsible for the decision process, milestones and gates as well as costs, time plan and other specifics concerning the planning of the project. The company's innovation process is a self-developed process, grown over many years and which is based on influences from other industries, research and different academic theories. They constantly review the way they operate, but the structure of the product development process is the same for all departments although the activities involved may vary between the different departments.

One person argues that an agile operating process is attractive to the company and something which they want to achieve in order to be flexible, efficient and capable of implementing things faster. However, this person claims they have difficulties of adapting it to their work as it is designed for software and not hardware which they are handling. The perception of this person is

further that implementing more simulation driven development could facilitate this and shorten the lead times.

The product development is partly divided into the different parts of the truck, referred to as line groups. One or more employees from each affected line group is chosen to carry out the projects, but not all people in the groups will be involved in all projects. The surrounding functions like purchasing, production and marketing are also involved in each project. Some work with the projects full time while others are involved in several projects at the same time. The project covers all the phases of the innovation process but depending on what phase the project is in different competences are needed. The different projects form a grid where the line groups line up horizontally and the projects are under. The projects are cross-functional and can affect several line groups. The marketing department who knows what the customer wants decides what projects to launch. Within the company they have progress meetings and gates to make sure that all projects are on the right track and to evaluate if more resources are needed or if the goal set needs to be changed.

The company has an initial phase of their innovation process concerning research and advanced engineering which circles around innovation and trying out more wild ideas. Some stay in this phase permanently while some are borrowed from the large R&D department. This department is a bit more decoupled from the rest of the R&D department and has more freedom to decide over their own budget. During this phase a lot of cooperation with universities and academia is conducted.

The next phase of their innovation process concerns the conceptual development and pre-development and is where decisions are made concerning how concepts should actually look. They do not develop dedicated products such as trucks, but rather a construction toolbox of alternatives which can be combined to fit the customer needs. This phase is mostly performed by senior managers with a lot of knowledge about the company. Big changes can be made during this conceptual phase and all the product goals and business cases are verified here. The idea is that the conceptual phase should also be cross-functional and involve the next phase which is development.

During the development phase the company focuses on product development and industrialization. They are given project specifications and product characteristics from the conceptual phase which they analyze to see whether they can perform it or not. If it seems reasonable they accept the project. This phase then includes activities such as defining the project, developing the product, managing purchasing activities and preparing production leading to production ramp-up. There are a lot of tests being performed in loops until they are satisfied and can move on. Once the project is launched it is very clear what is to be done during this phase and it leaves little room for innovation though there is still room for small changes while involving a lot of problem solving. The development phase can further share knowledge if needed to the succeeding phase, maintenance. All errors that occur after the product is sent to the customer are managed by the maintenance phase. They either solve the problem themselves or send it back to start a new project in order to solve the problem. These teams are more general and do not have the same detailed

knowledge as the teams of the development phase, but they can ask if they need any help or information. Information concerning problems and dissatisfaction among customers that is received in the maintenance phase is sent back in the process.

The R&D department covers all these phases and the idea is that knowledge of the organization should flow between them. The idea and hope is further that employees follow from the research phase to the conceptual phase and all the way to the development phase, but one person argues that the management cannot know this as they cannot see who has been involved in the different phases. Previously the company did not have the same division and technical risks were often handled in the development phase, one perception is that this mindset remains with managers even though the risks should be gone by this phase.

Ideas within the company are believed to arise from anywhere within the company but they experience difficulties concerning how to take care of them. Many ideas arise from daily operations and product development concerning problems that the employees are experiencing, but there is no process for how to pass their ideas on or how to save ideas. This makes them dependent on the employee behind the ideas to remember it and to monitor when in the future it is possible to revisit, but one perception is further that it is also dependent on the interest of the manager of the employee. Previously the development processes were not as structured and everyone had more free time and could talk to others about their ideas without a decision being required. Now it is more process and budget controlled and the ideas must go through a lot of different levels to get permission and the resources to work on the idea. If an employee has a great idea, but it does not fit into one's current project there may be an opportunity to start a new project.

The company has an initiative which is a process designed to take care of the employees' ideas. The employees are invited to pitch their ideas and the ones that are selected are allowed to work full time with their idea for six months before meeting a panel evaluating if the work is to continue or if the employee should return to its normal duties. The initiative started within R&D but is now scaled up for the whole company. It is run entirely in-house although consultants or experts might be involved to train participants and people involved in the process. The criteria for the selection of ideas and projects is that they should entail something that the company currently is not working on. The gap from employees who are part of the process are filled by the human resources department who arranges for consultants to jump in. The ideas come from the whole company and one person argues that the individuals often feel listened to and satisfied about being a part of the process even if they do not qualify. This person believes the participants value the received training and possess more knowledge of how to succeed the next time.

4.1.1. Company Trains

The train company has divided their innovation process according to different parts of the train. The process involves a theoretical study, application in practice for example by prototype or demonstrator and finally how the company should commercialize it. They further have an evaluation process of the technology readiness level showing the degree of maturity of a development project. To reach a new level they conduct gate meetings controlling the requirements

that need to be fulfilled in order to enter the next level. The requirements are quite fuzzy in order to suit different kinds of development projects. There are goals of the development projects that must be achieved, but one person argues that these can sometimes be perceived like requirements as the project is carried through. This person further claims that if the goals are poorly set, they can cause unnecessary sub-optimization in order to reach a specific goal. Sometimes, in the end of the project or in the larger perspective this person argues that these sub-optimizations show to be indifferent to the end customer and the market the goal was based on. One might spend a lot of money on fulfilling a goal instead of achieving what lies behind the goal. This person further believes that the company has trouble anchoring back to reality and instead focuses solely on achieving the goals.

During the various phases of the innovation process different competences are needed and hence different departments are involved. The projects often run for 3-4 years, but many take even longer time. The same employees often work in both delivery and development projects, although some devote more time to one of them. The perception among the interviewees is that the advantage of having employees working in both project types is that what is developed during development projects can be introduced directly into delivery projects if employees can see a fit. One person further emphasizes that during the innovation process it is important to collaborate between different departments in order to understand and adjust to each other's limitations and requirements and thus enable for all requirements to be met.

The company sends work packages to engineers in other countries in order to deliver their products there. To enable this, they send emails and documents which describe what needs to be done and the engineers perform the tasks and send results back. Order deliveries are made by customers and they want the projects finished within a certain timeframe or else the train company will receive a fine. One person believes this hampers the level of optimization possible as the deadlines cause the company to finish projects once the product is good enough to satisfy the requirements. This person believes more optimization and further development is possible during development projects where they are looking towards future markets, even though they have deadlines for these projects as well.

New ideas within the company emerge through research or through project experience. The company has employees working with both small and major innovations in research. Ideas also arise when the company encounters problems that lead to brainstorming meetings which forces them to think again. These ideas can occur both during delivery projects and development projects and the budget is allocated to the proposals submitted and approved. The criteria for approving proposals are concerning the ideas possibility to enable some kind of competitive advantage and being something unique to the market. One person argues it should make the process or product cheaper, easier or cut the development time. The proposals are evaluated by a global function, but this person claims the process is long and not always transparent to the rest of the company. There is no system for saving the ideas and they are therefore dependent on the employee behind the idea, if this employee disappears so does the idea.

4.2. Company Internal Knowledge Sharing

This section presents the empirical findings of internal knowledge sharing for the investigated companies. It entails how the sharing of knowledge and information is encouraged within the organizations and what measures are present to enable this. Further, findings of the different perceptions of how encouraged the sharing of information and knowledge is within different levels of the organization is presented.

4.2.1. Company Cars

The car company's vision is believed to be well communicated throughout the organization, although it remains unclear how different departments break it down in detail and translate it to realistic terms applied for their context. Transparent communication is encouraged throughout the company, although some of the employees find this difficult at times. The company has different forums where the employees exchange information. In the R&D department, for example, employees with the same role from different product streams have meetings once a week where they update each other about the status of their projects and share information. Moreover, some product streams have joined coffee breaks once a week which are very appreciated. Due to the size of the company it can sometimes be hard to find the right person to answer a question, but once one finds this person it is easy to communicate. All the interviewees have been working in the company for many years and they express that this aspect gets more natural over time as they build relations with people all across the company.

4.2.1. Company Trucks

The common perception is that the overall vision of the truck company is well communicated throughout the organization, however there are conflicting opinions about whether the strategies are well communicated or not. The vision and plans are communicated mainly through meetings and as this information travels down in the organization a lot of different interpretations are developed of what is most important. In the end they are all competing over the same resources and budget, which can create disputes and conflicting interests. To have a more common understanding and behavior one person expresses that the communication and anchoring of the strategies might need adjusting.

Higher up in the organization structure the perception is that information is shared through an open environment where everyone is entitled to an opinion. Lower down in the organization structure the perception is rather that information is not that encouraged to be spread. The experience among this part of the organization is that there are physical restrictions such as access to buildings and systems which hamper the exchange of information between departments and employees. It seems however that the longer an employee has been within the company the broader contact network and wider experience the person has which facilitates the spread and access to information and knowledge within the company. The department for R&D has further made a choice to have only one canteen to provide a meeting point for all its employees. A lot of informal meetings happen here as well as during coffee breaks. However, the whole company is spread out in 5-6 different locations within the same city and there is no common location where they can all meet informally.

Employees of for example the research department can invite others to inspirational meetings and lectures to spread knowledge, but one person argues that no one is forced to go to these. Research done by the company is spread through the use of email and their website, but they cannot know who takes part of the information. However, once a year they have a day where they do an exhibition of the entire research portfolio and invite everyone to come.

The overall view on resources invested in R&D is to remain competitive and deliver vehicles that the customers want. The company's main purpose of R&D is to learn over time and therefore also create new and better products. However, one person claims this can also depend on the mindset of creating long-term or short-term business and emphasizes that the revenues come from products. During the conceptual phase projects are viewed as educational and one person argues that if they fail the company knows that the need is still there, but with current knowledge they cannot solve it. Another person argues that the level of defeat experienced is dependent on whether the educational intent is well informed to the project team or not. The further into the process the more time and money has been spent and the company will therefore want to finish it. Most projects that are discontinued are stopped between the conceptual and the development phase.

4.2.1. Company Trains

Information sharing is encouraged within the train company, but it is considered to be difficult and is often handled one document at a time. There is no constant exchange of information or process for how it should be handled. Competence centers are gathered a couple of times a year and occasionally a collaborative project is set up with engineers from the various sites and information can be exchanged. Whether the information from these meetings is communicated further varies. Workshops are held with people from both inside and outside the company with different specialist competences. A technical forum is further planned to start, but presently seminars or presentations at departmental meetings concerning current work is managed on behalf of one's own initiative. During coffee breaks there are many ideas created and a lot of exchange of advice, information and knowledge.

The company has previously experienced challenging economic times where little resources were used within R&D as the company was in survival mode. Now the situation is very different and the company has a lot of deliveries that need to be followed through in order to avoid fines. With all these projects under way the company has a great revenue, but the resources and people they have at their hands are needed in those projects and are not able to focus on developments in the same extent. The company's motive with R&D is mainly to create good products, but even if a project would fail one person believes there is always value in a project and the knowledge gained from it. This is however further believed to depend on whether it is possible to pass the knowledge forward and whether the shutdown of a project is well motivated to its team.

4.3. Company Environment

This section presents the empirical findings of how the investigated companies interact with their external environment. The focus of the findings concerns the companies' customers, suppliers, competitors, academia and public authorities and how cooperation between these are pursued.

4.3.1. Company Cars

The car company's main customer segment comprises of everyday individuals who can provide good feedback on what they personally miss and where they experience problems with the product or services. They are however unable to give insight on what they are going to need in the future and the company therefore conducts studies of markets and customer data as well. Deputy customers are present during the project process and provide feedback and requirements that need to be translated to specific product attributes.

One person points out that in ideation phase it can be preferred to understand the human rather than the customer since the present users of their products might not be the users in the future. The employees that work in the early stages of development are not in direct contact with the customers. However, it is of high importance that customers know how to use their product and its functions. To obtain information regarding customers' interaction with the vehicle they send out a request to the business owner who conducts surveys and delivers the results back to the teams. After a release of a new product they send out further surveys and perform investigations together with the customer to gain feedback.

The company's relationships with suppliers vary depending on the extent of support they offer each other and how long they have cooperated. In some cases they are in need of minor parts and in other cases full support from the supplier is needed. Some departments are dependent on technologies that are not developed in-house and therefore have a lot of full-service suppliers. In these cases they work closely together to ensure that the technical development is aligned with the project's criteria. Fairs and exhibitions present good opportunities for the company to get informed about the suppliers' projects and what they are planning to develop in the future. Sometimes suppliers are invited to show their current projects or demonstrate their products.

The collaboration between different companies within the car industry is first and foremost carried out in the setting of cooperation bodies. Here technical experts from car manufacturers around Europe meet to discuss what kind of regulatory requirements should be developed and how. Their cooperation is strictly regulated but it is a necessity in order to develop good legal requirements. If a good framework is set concerning the cooperation, they are able to exchange a lot of information and thus learn a lot from each other, which is very appreciated according to some of the interviewees. Besides the cooperation with competitors they conduct monitoring activities to keep track of what competitors are doing. The company claims a well-known method in this industry is to buy and disassemble competitors' cars to benchmark each other's products and gain hints and insights about their development.

4.3.1. Company Trucks

Understanding the customer is an important part of the truck company's strategy to be able to offer better products and attributes. One person argues that they encourage all their employees within marketing, R&D and purchasing to meet with their customers. The marketing department identifies the customers and determine which ones are important to meet, they also work as a link for employees lower down in the organization who are not permitted to meet with the customer to

provide them with the information needed. There are employees of higher levels of the organization that meet the customers from different points of view. They make visits to the customer to understand their business, what challenges they have and how they make their money in order to understand the requirements of need. They further look at their customer's customer to understand the whole transport system. It is also possible to find out new things about the customers by asking another team within the company with another point of view gained from their visit. They further have a customer panel which they can utilize, this is mainly done during the conceptual phase.

It is important for the company to involve their customers to gain their feedback on things they have done or plan to do. In the last couple of years the company has therefore included the customers more and more in the early stages of their development projects. These customers usually want to be in the frontline of development and are willing to pay for the company to perform what they inquire. This often demands a balancing of the requirements as the customer might have a great idea but is unable to see the negative aspects and disadvantages of it. One opinion is that the Stage-Gate like process that they are currently following is based on the fact that the future customer need is given, but in reality it is not. An innovation process must involve the customer early and gain feedback, something this person considers to be hindered by the process they are using and should be improved. During traditional research with academia the customers are typically not involved.

The company has the strategy of performing most of the development themselves and there is therefore little cooperation with suppliers. If the knowledge or capability is missing within the company they subcontract it. The company generally has a limited access to plans and developments of their suppliers, but most of their suppliers are providing simple products with little development over time. The supplier's developments can however be used to understand what the competition is working on and to be informed of upcoming trends concerning the supplier's product to know where the development is heading. The main contact with suppliers is dealt with by the purchasing department with support from the development department. The suppliers hold a lot of information about how their products and equipment work which is highly valuable for the teams within development. The company is using many different suppliers to not be dependent on one supplier in case something would happen, but there is a complex process of adding a new supplier to the company. In research projects however, they almost always cooperate with suppliers to try out different concepts and buy in specific parts for the project prototype.

It is a known fact that although cooperation between competition in the market is only performed under well-structured circumstances each player on the market buys the competitors' vehicles to benchmark each other. The perception is however that more cooperation would be valuable but that there are structures and laws as well as the need to protect the intellectual property and patents limiting the feasibility. There is a selected team within the company working with legal requirements and they keep a close relationship with the authorities to stay informed on upcoming changes. The company is further involved with cooperation projects concerning new proposition of regulatory requirements to make sure that they are formulated to not hamper the transportation industry. The state funds different research programs involving both competitors and

subcontractors to the company to strengthen the Swedish vehicle industry.

4.3.1. Company Trains

The train company aims to be able to use the same product platform for the entire market, although important parameters vary across the globe. To enable this, they make use of modularization which enables them to alter the product for different customer needs. Particularly the infrastructure for trains is different in countries around the globe and one person argues that as the company is present in a large part of the world the modularization is of high importance as the costs of changing the infrastructure is too high for any country to consider it.

The company's sales are mostly from public procurements. Feedback and information from the customer is collected early in the process before the design is set, as there are different tenders involved as well. Responding to tenders is a communication process and involve a modification of requirements along the way. One person argues that those who work with the vehicle have direct contact with the customer but that the developers on the other hand have a long succession to get in contact with the customer and its technicians. However, this person claims that when the developers do get to meet the technicians great things are accomplished and they move forward much faster. If more collaborations like this would occur this person believes they would achieve better results faster, but that the openness of discussions is however limited by finances and laws concerning collaboration. For many of the projects the customers hire a consultancy firm functioning as a third part between the company and the customer as the consultants possess knowledge about the train and infrastructure which the customer does not. One perception is that as the consultants are paid by the hour, details that may not be important in terms of the function of the train can prolong the process and thus costing the customer money if the consultant firm wants to extend the project. The train company will perceive the requirements as met, but the consultant will argue that they are not. This creates problems when the customer does not have sufficient knowledge themselves and the consultant they hire is not sufficiently knowledgeable either. As the projects last over a long period of time a relationship and close collaboration with the customer is created which often leads to continued development potential.

There is also a long way for the developers to get in contact with the suppliers, but not as long as to the customers. One person argues that this has to do with the fact that a purchase made by the company from a supplier does not involve the same amount of money as the deliveries to a customer does. Therefore, a closer dialogue with suppliers is possible. Another person argues that a close relationship with the company's suppliers is further needed in order to succeed with the time aspect of projects, but that this also limits the iterations possible. When choosing a supplier, the company has workshops where they go through the proposals and make agreements.

The company has a limited number of competitors and tenders usually come from around five other companies. The company is involved in cooperation with their competitors where they create good standards for verification to match with suppliers. Moreover, they are involved in EU projects with both competitors and suppliers aiming to create knowledge for everyone to make use of. One person experiences that collaborations with external partners are rewarding and that there has been

a greater exchange of information due to the differences in previous experiences. There is however a risk of it being too big of a difference concerning the direction the parties want to take, but the vision and set goals are believed to help with this.

4.4. Futures Studies

This section presents the empirical findings concerning the futures studies of the investigated companies. It entails how the companies are planning for their future, what techniques and methods they are using and how these align with their innovation processes.

4.4.1. Company Cars

The car company claims that they engage in futures studies during the whole product development process. One of the employees describes the futures studies as the strategy which they have processes for. Every product stream makes product development strategies each year describing the direction that they desire to take. They start with a technology insight where they scan the type of technologies that are out there. They get a lot of input from different areas for this technology insight which they then try to connect to their own reality and possible future condition. They also get scenarios from the corporate level, which mainly describe a preferred state of the future. The scenarios are mostly focused on where the company is heading, but the guide is open with room for interpretation as it should be adapted for each product stream's context. Every year they sit down with all teams and investigate the kind of research that they have today, how they see this evolving in the future as well as looking for inspiration for interesting research areas for now and up until 15 years ahead. Normally each product stream focuses on their own area, but they do joint work together when they find areas that need competences from more than one department. In these cases, one department commonly takes the lead and the other one supports. The company further has a brand attribute guide which is a bridge between corporate strategy and product streams, and which is produced by the business owner for each product stream. This acts as a link between the abstract corporate strategy and the actual technical development.

One of the employees argues that when it comes to futures studies there is no need in restraining one's work to what is far away, opportunities can arise where the development can be brought in earlier than expected. Especially regarding the digital world that has a faster pace of change. If they find pure software changes they can be introduced relatively quickly, which is supported by their new agile way of conducting the innovation process. Further he explains that networking is an important parameter in future studies, it can create important links to what is happening in other continents and countries as well as in research and politics.

The company further has a decoupled group that conducts future tensions and where they have an outside and in perspective on what might influence the company. They attempt to understand what parts of the environment that are relevant and should be studied and then gather as much information about them as possible. Further they evaluate if it is something they should incorporate in their strategy, and if so, how it should be realized. By looking at trends they try to estimate how things can unfold and linking them all together to see patterns. The result of a foresight can be difficult to handle according to one of the interviewees. This is because it often displays future

situations that are not looking so bright and would involve huge structural changes for both their company and the whole industry. Hence it is hard to communicate the results across the company.

Many of the problems the company is facing are of a complex or even wicked nature, making it hard to grasp and break down. In these cases they believe scenarios can be of good use since one can never know for sure how the future will unfold. When it comes to scenario techniques they are conducted both on the market side and the technology side of the company, as well as in the management department for business strategic reasons. Their implementation differs slightly, but employees from the different departments are included in each other's processes to provide complementing competencies and knowledge. Moreover, they have a decoupled team with representatives from different departments that performs a scenario technique based on the axes-scenarios once a year or every two years.

In the R&D department the scenario process starts by conducting research where some look at trends concerning the car industry and others look at global trends. After the research they gather in smaller groups to go through their findings. They translate their observations and note them on small cards whereupon they invite employees across the entire company to participate in a workshop where they analyze the cards in clusters. These workshops are usually very eye-opening as they often find new possible explanations of phenomenon. After the workshop they analyze the possible impacts in relation to the uncertainty and put the two most significant drivers of trends on two axes creating four fields, rather often these axes concern political stability and technical adaption. For each field they create a separate scenario, which can be described in quantified figures or stories/narratives and which always seem relatively likely to occur. The further in the process they get, the more the industry is reflected in the scenarios. The final scenarios of the R&D department lay the foundation of their research strategy, although they are presently not communicated further to the corporate level of the organization.

One of the reasons the company has begun to use the scenario technique is that they started to engage more in user experience and wanted to develop an understanding of people's feelings towards the car. One of the employees believes that it is a suitable tool for sorting thoughts, hence generating ideas. If the ideas do not fit in the company's business, they have a chance of getting developed in a product lab which mission is to create products and services which are presently not offered by the company. This person further elaborates on the importance of having an innovation system that is both reflecting and acts. Scenarios and other foresight activities provide an opportunity for reflection whilst the product lab can act. In this manner they can support each other, create interesting cooperation and generate learning to the organization.

4.4.1. Company Trucks

The truck company has meetings once a quarter to plan their strategic product development. It is important for them to understand the customer's business and the entire transport system in which they operate. From there they try to find the most efficient solutions with optimal attributes for the customer. Looking not only at their own, but also at the customer's business case as one person argues that in order to become profitable they need to make their customers more profitable.

Planning for the future is mainly conducted during the research and conceptual phases where there is more time and ability to explore the future. Once a project starts and enters the development phase the view of the future is set and the project goes on with little opportunity to influence the outcome of the project even as things change over the years they are developing.

The inputs that the company use for their external analyses are aspects concerning what the competitive situation looks like, the development of technology and where these areas are headed. It concerns social analysis, customer requirements and wishes as well as legal requirements and what they want to influence in legislation. From this they try to understand what this means for their company, what they need to do to satisfy this and what products they should develop. Each component team has a responsibility to investigate the surroundings and do an external analysis. However, the external analyses that the company performs are considered to be more on the business level, regarding global changes rather than product planning.

The company tries to work with a scenario-based strategy and product planning. The scenarios are however by some considered to be poorly reflected in the strategies and there are conflicting opinions on whether this should be the way to operate. Their scenario planning starts with the company management and is then broken down into each division's reality and enables them to use it in their own way. The plans that are determined are communicated up in the organization and put together to create a big picture over the company's plans and enable them to monitor it. One person believes that the mindset and culture of the company limit the introduction of scenarios. This person argues that ultimately it is about individuals who look at risks and threats regarding the future in different ways and whether the scenarios are implemented depends on the managers who are there and set the culture.

The scenarios are created through a few workshops and after the participants work on their own before they come back and have new workshops. They look from the outside and into the company and business and they do not limit what data they take into these activities. They start in macroeconomics and global trends and pull them to their extremes to find out what it can mean for them as a company. Many parts of the organization are involved in the process and the scenarios are further spread through meetings. The key is to make plans and prepare for all scenarios and then continuously monitor to activate their plans. One person argues that by having a wide range of competences involved, they can not only create good scenarios, but also a better buy-in effect for them within the company. From the research department, they have three dominant future scenarios, for which they then try to make one common plan. However, one person claims that it is very easy to fall back on believing or hoping for one scenario and then lose the readiness for the others.

The scenarios they have are drafts of storytelling and movies to illustrate what the scenarios mean, but they are traditionally broadly based in text and with limited movement. They make new scenarios when they see that something big is going on which risks breaking up the entire value chain of their industry. The scenarios they currently use were made 10 years ago and they realize they need to make new ones but the budget makes it hard to do so. One person claims that the scenarios are known by some in the organization, but that as soon as someone else within the

company sees that they need a strategy they hire a consulting firm which starts over to do its own strategic scenarios.

From the scenarios created they make roadmaps for strategies concerning what technical goals they have for the future. Some roadmaps are instead based directly on trend analyses and forecasts to provide their best guess about the future. The roadmaps are usually set for 2-4 years ahead and are based on what capabilities and opportunities they have in the line. For each division of the strategic area they make a roadmap based on the customer need and this is continuously iterated. The budget is divided between the divisions and they launch projects based on their capacity while making sure that it is the right projects that are launched. One person shares that in the research department they are also working with backcasting set for 7-10 years ahead and focusing on signals of what could happen and how they can be prepared for this. During milestones and gates the company makes sure they match the predicted plan, but they do not zoom out to make sure that they stay on track.

4.4.1. Company Trains

The company has tender engineers who are responsible for finding tenders for the future. They are sensitive to what customers want and have contacts to understand what is going on in the company's surrounding environment. These tender engineers hand over the information and requirements concerning the tenders only once they are won, there is therefore little cooperation between the developers and the tender engineers both before and after the tender is through. There are further engineers working with research and development. These must be sensitive to what is discussed in the academic world and bring important knowledge back into the company. The company monitors global trends such as technological, social and environmental trends. When big macro trends like electrification and urbanization seem to occur the company needs to understand what products will be required and how this will affect the company.

5. Analysis

Presented below is the analysis of the empirical findings in comparison with the theory of this study. The analysis is divided according to the analytical framework with the initial parts of Innovation Process, Futures Studies and Foresight in Innovation Processes. Each part analyzes one research question and is comprehended to answer the question at the end of each part.

5.1. Innovation Processes

The analysis of the Innovation Process has been divided into the structure of innovation processes, company internal knowledge sharing and company environment to ease the understanding of each subject. Comparisons between the companies are emphasized and the findings are connected with the theories concerning innovation processes

5.1.1. The Structure of Innovation Processes

Both the car company and truck company have four phases of their innovation processes. Although how they refer to these phases are different and somewhat inconsistent, the description of what goes on in each of the phases are conforming. There seems to be an initial phase of advanced engineering and research followed by a conceptual phase where concepts are generated and projects formed. The train company has delivery projects with clear objectives, but for their development projects where they are less restricted by the time aspect, they have more opportunity to innovate. This can be resembled with the two initial phases of the other companies and these further resemble the initial stages of the Stage-Gate process presented by Cooper (2001). The Discovery stage of the Stage-Gate process involves ideas being generated and scenarios being created from historical and future trends and the stages Scoping and Building the Business Case both involve analyzing the surrounding environment and market resulting in a project definition and plan. The phases further conform with the two initial stages of Eppinger and Ulrich's (2012) Planning and Concept Development where the initial opportunity is identified followed by an analysis of the customer needs and the market. These different stages and activities are described by Cooper (2001) as the fuzzy-front-end of an innovation process. Following these phases all companies seem to have a phase of industrialization and development where the projects are carried out and production is ramped up. In this phase, the directions are strict and there is little room for changes. This phase conforms well with the stages Development and Test and Validation of Cooper's (2001) Stage-Gate process where the detailed design and the operation and production processes are developed, followed by tests and validation of the entire project. The activities of these stages further conform with the activities of the stages System-Level Design, Detail Design, Test and Refinement and Production Ramp-Up presented by Eppinger and Ulrich (2012). After these stages the Stage-Gate process suggests a launch and commercialization of the product, which is also the final phase of the train company's innovation process but is further present in the innovation processes for all of the companies in this study. The final phase of the innovation process for the car company and the truck company is maintenance where the after launch value of the product is maintained.

All the investigated companies have divided their innovation processes according to different parts of the vehicle and have further divisions within the departments responsible for each component. The companies have also adapted modularity to their products and thereby stress the importance of the interfaces to be stable in order for all of the teams working on components to be more or less independent from other parts or components of the product. Conforming for all companies is further that different departments are involved in different phases during the innovation process since different competences are needed at different stages. During the innovation processes all the companies are conducting some form of gate meetings where the projects are evaluated to see if they should proceed or not. This would confirm that there is a use of the go/kill decision points discussed by Cooper (2001) present in manufacturing companies within the vehicle industry. These meetings could possibly further be expanded to incorporate scenarios as a point of reference for the outlook on the future developments.

As described by Schwaber (1997) the adaptation of an agile methodology enables a company to be flexible during the innovation process, something which the car company has identified and are trying to achieve. The truck company is also aware of this but has not yet been able to adapt to this methodology. However, the loops where tests are performed iteratively discussed by Copper (2001) concerning the Agile Development can be found in the truck company during their development phase.

All the companies of the study claim that ideas arise from all parts of the company and that they often occur during daily operations when employees experience problems. Valuable ideas that pass the company's different kinds of selection criteria are brought to the pre-development or fuzzy-front-end of the innovation processes. According to the car company the purpose of this is foremost to create an understanding of the feasibility of the idea. This is somewhat conflicting with Cooper (2001) who states that it is during the fuzzy-front-end of an innovation process that new ideas are generated. Even though it might be in the fuzzy-front-end that the companies elaborate on ideas it is clear that the generating of new ideas is not solely restricted to this phase.

For all the companies of the study the prominent ideas are evaluated at management level to be approved to start and receive resources, which resembles part of the activities performed during the Scoping stage of Cooper's (2008) Stage-Gate process. It seems the ideas of the companies are evaluated based on the competitive advantage that they would contribute to or how they would add value concerning the processes, product or customer. During the stage of Discovery Cooper (2008) suggests the creation of scenarios which would imply that these could be used to evaluate the relevance of the ideas in the succeeding stage of Scoping, presenting a chance for companies to involve scenarios in the evaluation points. Ideas which currently do not fit the car company can be proceeded as start-ups, while ideas that do not fit the current project for the truck company are proceeded as new projects within the company. The car company has a backlog where they can save ideas for later, although it remains uncertain to what extent this is used and how elaborated an idea has to be in order to be considered. Both the truck company and the train company are lacking a process for saving ideas that arise, making them person dependent. According to Nonaka *et al.* (2000) knowledge which is personally connected and tacit is harder to pass on. During an innovation process this would suggest that knowledge and information must be spread between

the different stages and departments in the process to both create knowledge and to develop a good product, this should also include the ideas that arise within the company. Both the car company and the truck company further have some kind of forum where employees can hand in ideas for evaluation, which reinforces the dissemination of ideas within the company.

5.1.2. Company Internal Knowledge Sharing

All the companies of the study have different teams responsible for the components of their products. It is therefore important that the interaction between the different departments and teams flows in order to achieve a good end result. Cohen and Levinthal (1990) claim that the greater absorptive capacity a company has, the more new knowledge can be utilized. All the companies of the study are encouraging exchange of information and knowledge, although they all experience that this can be difficult at times. They have forums where employees are encouraged to meet and share information and knowledge with each other and further they all seem to agree that much is shared during informal coffee breaks. Over time they claim that employees of each company develop relationships with people from different departments which is helpful when they need information or help.

The visions of the car company and the truck company seem to be perceived as communicated well, although related successors such as the strategies or terms for each component's context seem more difficult to keep unified. Day and Schoemaker (2000) emphasize the importance of being open to experimentation and value the learnings achieved even if it results in failure. This can explain the companies' approach to their projects in the fuzzy-front-end where a shutdown project, if motivated well, does not imply negative reactions from the employees involved but instead they shift focus to formulating what they have learnt. The car company further strengthens Day and Schoemaker's (2000) arguments by introducing start-ups intended for exploration of new opportunities without affecting the company's existing business. Conforming for the companies is the purpose of their investments in R&D being both about learning and producing good products. This further contributes to Cohen and Levinthal's (1990) view on absorptive capacity being an additional result coming from investments in R&D.

5.1.3. Company Environment

The innovation processes described by both Cooper (2001) and Eppinger and Ulrich (2012) involve the customer at various stages of the process and they emphasize the importance of understanding the customer's need. The companies of the study understand this reasoning and they all interact with their customers to gain feedback about their products and services. Both the car company and the truck company have some kind of customer panel which can be involved during the whole innovation process, customers are however mainly present during the early stages of the process and after launch. This can be explained by Monsef and Ismail (2012) who argue that diverse cooperation is specifically important during the fuzzy-front-end of the innovation process since it helps creating successful ideas that have a chance to get implemented before possibilities for adjustments become limited. This could be the reason why the truck company has in recent years been trying to involve the customers more in the early stages. Moreover, Nonaka (1994) discusses tacit and explicit knowledge and the different ways of how these two different types of

knowledge are transferred. By visiting the customers in their own environment, as the companies of the study are doing, they are enabled to exchange not only explicit knowledge but also tacit knowledge, facilitating their perception of the customers need which in turn contributes to a more suiting final product. When it comes to the train company, they operate on customer orders. Therefore, they tend to have a closer relation with their customers since they interact throughout the whole innovation process and have the time to establish and maintain a relationship with them, alternatively the consultant acting as the middle hand.

Cooperation with suppliers varies among the companies. The truck company performs most of their development themselves and therefore has little cooperation with their suppliers, although they can be more involved during research projects. Most of the interaction with suppliers is handled by the purchasing department. Likewise, the car company does not engage in many collaborations with suppliers, except for when they deliver full-service solutions, which demands a close cooperation. The train company has a closer cooperation with their suppliers, although for some employees there is still a long way in order to get in contact with them. This can create problems when managing the time aspect of their innovation projects. According to Adner (2006) having an innovation first on the market is only successful if the partners of the supply chain are ready for the innovation and able to support it. This should further encourage companies to extend the cooperation with their suppliers. Furthermore, Adner and Kapoor (2009) stress that cooperation with suppliers and customers is crucial as an innovation cannot survive on its own but must be supported by the complementors' innovations as well. For example, the electrification of cars has no value for customers if charging stations are not in place.

Adner (2006) argues that in order to create and enable end-user value, an innovation ecosystem where collaboration and combination of different firms' individual offerings should be addressed. In combination with open innovation discussed by Dahlander and Gann (2010), innovation ecosystems can help to enhance the innovation for a company by improving the absorptive capacity and knowledge creation. However, it seems like the companies are lacking continuous collaborations in innovation ecosystems aside from those with close suppliers and customer.

All companies of the study evince that collaboration with competitors occur through joint projects initiated by national or international bodies. All collaborations are however highly regulated in order to avoid anti-competitive practices in the marketplace. The collaborations most emphasized during the interviews were concerning legal requirements to ensure a functioning environment for all actors involved. Since the environment for collaboration between competitors is strictly regulated, it is conflicting with the concept of open innovation which accordingly to Chesbrough (2003) can make the boundary between the internal and external environment of the company more porous and in turn letting innovation move more easily. Thus, it is believed that the condition between competitors in the vehicle industry hampers the innovation speed. If the conditions were less strict maybe the companies could save time on the processes regarding benchmarking as both the car company and the truck company state is a well-known activity within the industry.

Lindsay and Norman (1977) argue that one must be exposed to unrelated knowledge in order to develop the absorptive capacity, which would support the companies' choices of further

collaborating with other stakeholders such as academia and universities. These partners are often in the forefront of development and can therefore contribute with much valuable information for the companies. The research center in which this study is conducted and which the companies are a part of, opens a good opportunity for the companies in the vehicle industry to get informed and up to date with the latest research conducted by academia and others. This in turn can facilitate the future synergies between the actors in the road and rail industry and their innovations.

5.1.4.Comprehension

A generic structure of an innovation process for companies within the industry of rail and road vehicles can be summarized to consist of three different phases: fuzzy-front-end, development and maintenance. During the entire innovation process there are decision points to evaluate the different projects' prospects. Although the companies have developed their own processes, the structure of the Stage-Gate process presented by Cooper (2008) is more or less represented by every company investigated. Although there are differences, similarities with stages and phases occur as well as gate meeting with kill/go decisions. Figure 13 presents a simplified visualization over the structure of an innovation process in the vehicle industry.



Figure 13: Simplified visualization over the structure of an innovation process in the vehicle industry.

All the investigated companies within the road and rail vehicle industry further adapt a modular product architecture with set interfaces and divide the R&D into teams focusing on different components of the product. These teams work in parallel during the fuzzy-front-end and development phases in the innovation processes.

For interaction between the component teams of the investigated companies to be smooth they exchange information and knowledge, supporting their use of open innovation discussed by Dahlander and Gann (2010). The companies' relations with customers, suppliers, competitors and other stakeholders also influence the innovation process during different phases. However, strict regulations considering information exchange seem to hamper the companies' ability to engage in collaborations. If there would exist stronger support for collaboration over the companies' borders as suggested by Chesbrough (2003), the value of open innovation could be enhanced and the speed of the innovation process increased. Therefore, the theoretical expectations regarding innovation ecosystems discussed by Adner (2006) and open innovation discussed by Dahlander and Gann (2010) are not satisfied.

5.2. Futures Studies

Duin (2006) argues that futures studies should involve economic, technological, social and political aspects of trends and developments. Even though most of these aspects are covered in the investigated companies' analyses, their main focus seems to be on overall global and technological

trends and how these could affect their company in the future. Duin (2006) further states that analyses are performed at various stages of the innovation process, but for the investigated companies these analyses are most present during the fuzzy-front-end and at the strategic level. All of the investigated companies conduct futures studies in the early stages of the innovation process (advanced engineering, research or conceptual). Tendencies of scenario methods are present in both the car company and the truck company where they can be found both at corporate level and in the development departments in the fuzzy-front-end of their innovation processes. The car company explains that each product stream creates a development strategy every year, which is compiled by the management into one corporate plan. For the truck company each component team is responsible for investigating their surroundings and conducting an external analysis, though it is not clear whether each result is communicated further within the organization. From the empirical findings of the train company it seems like they engage in futures studies through their tender engineers who are responsible for planning the future of the company. There are further engineers working with research and development, but what activities they perform and how they connect it to the innovation process remains unclear.

Mietzner and Reger (2005) argue that there is a better chance of coming closer to the actual future by foresight rather than forecasting. They further suggest that scenario techniques have the chance to offer more and get improved if combined with other futures studies, such as creativity techniques. It seems the companies of the study conduct creative activities in the fuzzy-front-end of the innovation process which might contribute with support for futures studies. However, for the companies of the study, futures studies are first and foremost used at corporate level, with the intention of planning for the future. These futures studies seem to lay the foundation for the company's corporate strategy, which is later communicated further to all employees within the company. Thus, there is room and maybe even a need for a closer connection between the futures studies performed in the fuzzy-front-end and those performed at the corporate levels in order to make full utilization of scenario methods in the innovation process.

The truck company develops several different scenarios, but they only make one common plan. The car company on the other hand uses the scenarios as a foundation for their decisions and they try to understand which of their products and components that fulfill the most of the scenarios. This indicates that they too develop several scenarios but only one common plan. According to Mietzner and Reger (2005) by developing good scenarios a company is able to communicate complex and unknown futures by a storyline. The scenarios created by the truck company might entail too much text in order to be communicated in a sufficient way, which may be why they are not transferred and used more within the company. The car company also finds the results of their foresight hard to communicate. Both the car company and the truck company believe that scenarios are useful for structuring thoughts and tackling complex problems which can be supported with Mietzner and Reger's (2005) explanation that they provide stories that are coherent, systematic and plausible. There is however no sign of the stories being used as input for anything other than the strategic planning at corporate level. The advantage of scenarios described by Mietzner and Reger (2005) is therefore not captured by any of these companies and can potentially present an opportunity for improvement.

Berkhout and Hertin (2002) suggest workshops as a good approach for futures studies, which is further supported by the empirical findings as all the companies seem to agree that work performed in their various workshops are contributing with good value and learning. Workshops are suggested by Börjeson *et al.* (2006) to indicate a good method for Normative scenarios which further supports the use of workshops in all companies. Huss (1988) argues that scenario activities provide insights about cause-and-effect relations which can support the car company's perception of the workshops having an eye-opening effect providing new explanations to phenomenon. The car company's workshops bring people with different competences and experiences together and provide a chance to elaborate on their interpretation of problems or states. This can enable the holistic view of the future which Ratcliffe (2000) argues occur when different images of evolvement are integrated. Besides, by creating holistic scenarios the workshops can nurture the companies' learning capacities. Day and Schoemaker (2000) claim that a company's learning capacity includes an openness to diverse viewpoints and a willingness to change mental models, which the workshops of the car company provides by inviting participants of diversity.

The pre foresight stage presented by Duin (2006) is well in line with the activities that are involved in the truck company's trend-analysis and pre-work for their scenarios. Further the interactive workshop and different roadmaps involved in the main foresight stage of Duin's (2006) stages goes well in line with the layout of workshops performed by the truck company, although they only produce one common roadmap. The scenario method performed by the car company's R&D department can also be linked to Duin's (2006) recommended initial stage. However, the company does not settle on a specific time horizon as they believe the time aspect to be less important due to the uncertainty of the development pace and the fact that digitalization entails possibilities of sometimes implementing solutions faster than predicted. The truck company only produces three scenarios which is conflicting with Duin (2006) recommendations of creating four in order to avoid developing a best and worst scenario with a mediating option in between.

The scenario methods used in the car company and the truck company are performed in slightly different manners. The truck company seem more familiar with the complementing technique of roadmapping making the link to the company's action plan strong but might risk the holistic future scenario of getting in the dark. The car company describes the adaptation of an axes technique to generate scenarios which can be associated with the method described by van't Klooster and van Asselt's (2005). What is common for both of these companies is that the scenario techniques they are using lay the foundation to their strategies which in turn are communicated further in the organization. In other words, both companies are failing to pay attention to the post foresight stage presented by Duin (2006), involving implementing the scenarios into the organization. They are mastering the creation of scenarios but much of the value they offer is not captured as it is not communicated and seized by the rest of the organization. This can further be supported by the perception among the companies that the vision is communicated well, while it remains uncertain how it is broken down in the different departments and teams. It can be difficult for employees to grasp what the strategies would entail for their department and work, which would emphasize the importance of communicating the scenarios that lay the foundation of the strategies within the organization.

According to Duin (2006) scenarios are more suited for radical change while trend-analysis is more suited for incremental change. Scenarios are therefore a good instrument to keep the long-term possibilities in mind during the innovation process, while trend-analysis can be used to create incremental changes. This would imply that the use of scenarios would be more suited for the fuzzy-front-end while trend-analysis would be more suited for the development phase as the companies involved in the study have to prepare for both radical and incremental change. Duin (2006) further argues that to enhance the quality of scenario methods there needs to be a diversity among the participants to create a more holistic view. This is something that the car company and truck company seem to agree on and they both have participants with diverse backgrounds for their futures studies activities. The truck company further emphasizes that by having a diversity among the participants the results will have a better chance of getting accepted within the different parts of the company.

Duin (2006) argues that the resources available for futures studies are limited both during good and bad times of business. In good times the company must attend to a greater number of deadlines and orders, while in bad times the lack of futures studies is due to scarce financial resources. This is confirmed by the train company, which during the last few years have experienced both good and bad times and seen how this affects their ability to attend to futures studies.

5.2.1.Comprehension

Futures studies are presently performed in various ways in the industry of rail and road vehicles, mostly at corporate level as a foundation for the company's strategies or in the fuzzy-front-end. The methods used are mainly roadmapping and trend-analysis, but axes method and scenario planning also occur. The activities are performed solely with employees of the own company. The main issue is that the information and results achieved with these methods are not communicated further within the organization, implying that the companies are not making use of the full potential and value of the results. Duin's (2006) basic theoretical framework for the use of futures studies in innovation processes, see Figure 10 in chapter 2.3.2, have some correlations with the processes and outcomes for scenario planning included in companies of the vehicle industry. The images of the future created through futures studies influence the innovation processes and create an impact on the innovation, although the impact is not as significant as it could be by applying Duin's (2006) framework. Figure 14 presents a simplified visualization of how futures studies presently are creating an impact on innovation processes in the vehicle industry. It is inspired by the framework of Duin (2006) where the boxes represent processes and the circles are outcomes of a process.

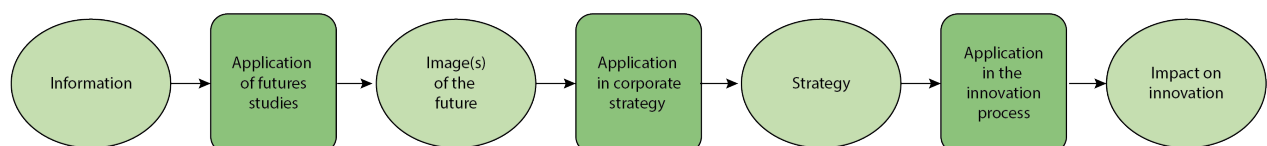


Figure 14: The common application of futures studies in the vehicle industry and how they create impact on innovations.

5.3. Foresight in Innovation Processes

Foresight and scenarios as explained, are in both literature and practice most commonly used in a corporate context to examine possible futures and act as an input for strategic decision making. The suggestion with the study is that the value of futures studies has the chance to increase if scenarios are adapted across the whole company. The reasons being:

1. The more people with diverse expertise that engages in the creation of the scenarios, the more indicators will be covered and a more holistic view can be achieved.
2. By attuning the whole company and culture it would make it easier for the corporate level to communicate the strategies and for each department to break them down and interpret what they could mean for their specific area

From the empirical findings it can be concluded that futures studies of some kind are present in all of the companies both in the fuzzy-front-end and at corporate level. Although given this information, it seems that foresight and scenario activities are often performed outside of the innovation process. The manner in which foresight is used in the investigated companies therefore conforms with the strategic role described by Rohrbeck and Gemünden (2011) which generates a common understanding of the future and directs the innovation strategy by providing guidance. Furthermore, similarities between the strategic role by Rohrbeck and Gemünden (2011) are present in the truck company and the car company as they both have differentiated departments aimed for managing strategic innovation and the technology targets for the company.

A suiting way of processing the images of the future would be through backcasting explained by Mendoza *et al.* (2017) as a top-down approach for strategic planning and Robinson (2003) further suggests backcasting as an approach for achieving long-term states. This would support the truck company's adaptation of the approach and enable them to look further into the future and to create a path of how to get there. Mintzberg (1994 in Drew, 2006) points out that the criticism on strategic planning is caused by its stifling innovation and lack of creativity, which presents a mismatch with the innovative environment. His observation therefore seems to comply with the empirical findings of this study, which clarifies the gap between futures studies and companies' innovation processes. Scenario activities are considered to be one of the most creative activities for the strategic planning. By restructuring the elements of the companies' futures studies and letting the scenario activities get influenced by diverse competences from all across the company, the companies are presented an opportunity to get creative inspiration to their strategic departments at the same time as the motives for the strategic plan has a chance to be better perceived by the employees of the innovation process.

The initiator role described by Rohrbeck and Gemünden (2011) triggers innovation of value for new R&D projects and by using it in the fuzzy-front-end it can enhance the innovation process. The underlying purpose of creating ideas for innovation suiting for the future that this role entails is somewhat present in both the car company and the truck company during their fuzzy-front-end in their innovation processes. This early phase is also where they see the most potential of extending the use of foresight, making it both natural and convenient to include the initiator role

in the companies' innovation process. In this way they can make use of the results of the scenarios straight away, as there is more freedom to make changes and less requirements and interfaces to consider in the fuzzy-front-end.

The opponent role described by Rohrbeck and Gemünden (2011) is in contrast to the initiator role applicable during the whole innovation process and enables for the product developed to be continuously compared with worldviews from outside the company's environment. Presently this kind of role cannot be found in the companies, but it is considered to be of great use since their projects in the innovation processes are running over a long period of time and the view of the future is unlikely to remain the same until the end of a project. For example, the opponent role would be beneficial for the truck company who explains that the view of the future is set as the project enters the development phase where it follows strict directions. The empirical findings imply that during this phase, quality assurance, technology readiness and alignment between the components are their main objectives since a lot of resources are already invested in the project. Furthermore, during the development phase the focus seems to be on reaching the deliverables leaving little room to take a step back and reflect on the products interplay with its future surrounding, creating another argument for incorporating the opponent role.

However, the adaptation of an agile methodology in order to be flexible is highly emphasized in the empirical findings, both by the car company and the truck company. The truck company tries to involve their customers more and tests are performed iteratively on the vehicles while the car company already has restructured their organization to an agile framework. The use of Agile Development as discussed by Cooper (2008) revises the new product during the whole process and by performing tests with customers on a more complete version of the product Cooper (2008) argues the product will evolve to better fit the customer's ideal. The companies seem to agree with Cooper's (2008) arguments which in turn would further suggest that they are ready for an introduction of the opponent role.

The car company explains that the agile structure allows for continuous development of the product through the production and even after launch. This complies with Duin's (2006) beliefs that the introduction of an innovation on the market does not mean the end of its development. The subscription-based service provided by the car company confirms his beliefs as it creates the opportunity to add value to the product for several years after its launch. Connecting the result of foresight to the later phases in the innovation process through the opponent role would according to Rohrbeck and Gemünden (2011) provide assurance of state-of-the-art developments and information on if or how the products could be refocused. Since there already exists a business model that supports continuous development as well as speculations that maintenance could become a part of R&D in the future, introduction of the opponent role on already launched products would have a chance to get well perceived.

5.3.1. Comprehension

There seem to be two ways in which futures studies successfully can be embodied in the innovation process with a third way ensuring alignment with management/corporate level. Futures studies can

be embodied in innovation processes either as the initiator role, to create more high quality ideas to build on, or as the opponent role, tuning the product during the innovation process to enable a better fit for the future market. However, the sizes of the investigated companies imply that the images of the futures further should be embodied in the corporate strategy to better align the many and different departments. Figure 15 presents a visualization of how futures studies should interact with activities connected to the innovation processes for companies in the vehicle industry. The framework is an extension of Duin's (2006) theoretical framework in combination with Rohrbeck and Gemünden's (2011) descriptions of the initiator and opponent role of foresight activities.

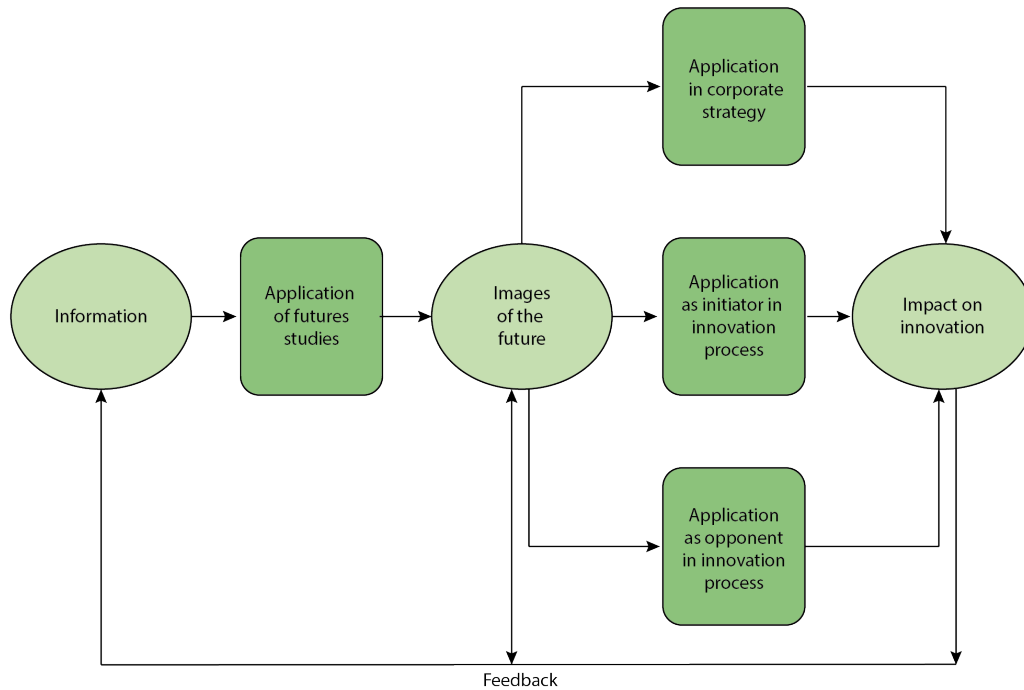


Figure 15: The recommended application of futures studies in the vehicle industry.

The boxes represent processes and the circles are outcomes of a process. The application of futures studies creates images of the future through a workshop regarding scenario creation. These images provide feedback in the form of information for the next round of futures studies and acts as input for three processes:

- *Application of images of the future in the corporate strategy*: where they, accompanied by forecasts and other foresight activities such as trend analysis and roadmapping, can formulate the company's strategy.
- *Application of images of the future as initiator role in innovation processes*: which would according to Rohrbeck and Gemünden (2011) trigger innovation initiatives and identify customer needs.
- *Application of the futures as opponent role in innovation processes*: which gives the project teams the chance of visualizing the product they are working on in the possible future environments that it should be complying with. The scenarios should serve the same purpose for projects in all phases of the innovation process: fuzzy-front-end, development and maintenance.

These applications provide impacts on the innovation, which in turn feeds back as information to upcoming futures studies. By allowing the scenario activity leading up to images of the future to solely refer to futures studies and the creation of scenarios, the participants of the workshop do not risk to leak sensitive information about the company, making it possible to involve different stakeholders.

6. Conclusion

For the investigated companies of the rail and road industry their innovation processes have been developed over many years and are thereby highly customized for each company. The activities involved in the individual approaches can however be compared. Common for all the investigated companies is that their processes consist of a fuzzy-front-end, where advanced engineering and research as well as concept generating occur, followed by the development phase where system level design and production ramp-up are the main focus. Furthermore, all companies share the division of component-based teams that work in parallel up until the launch of new products. After launch of the product, a phase of maintenance is present in each of the investigated companies, where feedback is gained through customers and possible improvements are detected. This would answer to the first part of research question one of how the innovation process is structured for companies within the industry of rail and road vehicles.

The conditions for the capacity to innovate depend largely on the company's internal knowledge sharing as well as their interaction with the surrounding environment. By adapting to open innovation companies are able to exchange knowledge and information, thus improve and speed up their innovation processes. The interaction in an innovation ecosystem further enables for information from external parties to be included, enhancing the capacity to innovate as more perceptions are included. The organizational aspects of open innovation and innovation ecosystems are thereby identified to have most influence on the innovation processes for companies within the industry of road and rail vehicles, thereby answering the second part of research question one.

To answer the question of to what extent futures studies are used in the industry of rail and road vehicles it is possible to say that futures studies first and foremost are used at the corporate level, to support planning and develop strategies. Furthermore, they are moderately used in the fuzzy-front-end with the purpose of detecting promising research projects, future development and product concepts. There is however potential and an identified need of making more use of the already performed futures studies as well as improving their communication within the organization. Moreover, the extent of futures studies performed can depend on how business is going at the time.

The main issue with the present futures studies conducted in the industry of rail and road vehicles is that the results are not sufficiently communicated within the company. There seems to be a gap in the use of foresight during the innovation process' phases of development and maintenance. One way of improving the integration of futures studies in the innovation process would be to involve employees from all departments in activities aimed at creating scenarios. The result from the scenario activity would then serve as input for an initiator role, an opponent role and as support for the corporate strategy planning. The initiator role would be placed in the early stages of the fuzzy-front-end to generate ideas while the opponent role would be recurrent throughout the whole innovation process in order to ensure market fit and future resilience of the innovation. By using the images of the future for more than one purpose it provides the companies with a chance to overcome the problems they are experiencing with translating the corporate strategy into specific

component teams' actions as well as aligning the direction of the different departments. This approach would thereby answer to the third research question concerning whether futures studies can be embodied in the innovation process to enable more future resilient innovations.

7. Recommendation

To include futures studies in the innovation process of manufacturing companies the recommendation is to start by performing a workshop where a scenario method is used to achieve visions of different possible futures. The workshop can be held solely with internal employees of the focal company, but it is recommended to include active actors of the company's environment such as customers, suppliers, competitors, academia or other important stakeholders as well. By including a variety of participants the results of the workshop will be better adapted to the entire environment of the focal company. It is recommended to perform this workshop on a regular basis to ensure that the company is adapting its operations according to updated prospects of the future. The workshop should contain activities and pointers for both prior to the workshop and during as well as after the workshop is conducted. These stages are presented below as pre, main and post:

Pre

One or two leaders for the workshop should be chosen and they will be responsible for the dynamic of the workshop and to keep the process moving forward. These leaders can either be part of the focal company of the workshop or externally brought in to manage it. They should have knowledge within the futures studies field and be familiar with the scenario method to be performed in order to lead the workshop in an efficient and successful way. At least one of the leaders must further have the skills to develop clearly visualized graphics of the scenarios developed during the workshop in order to facilitate a clear and efficient communication of the result of the workshop.

The participants must be invited and informed of the concept of the workshop well before the set date. The participants should be from different areas and possess varied competences to create a diversified environment. There should be at least one participant who is working as a futurist and who is familiar with the futures studies performed by the company in order to contribute with the perspectives of the future mainly discussed within the company. There should further be at least one participant from each part of the innovation process, the fuzzy-front-end, development and maintenance. These will contribute with competence and perspective concerning the innovation process and all its parts as well as enable for a natural communication of the results back into the departments of the process. Further, at least one participant who is responsible for the strategic planning of the company should participate. This participant will enable a consensus to be established between the strategy and the innovation process as well as enable for strategies to be developed which represent the entire company's aspects. This can further contribute to a well-adjusted strategy which enables interplay between different departments. At least one participant from the management of the company should further participate in order to connect the result back to the management level and create an understanding of the future higher up in the organizational structure as well. Finally, at least one participant from marketing or a similar department who has a close connection with the customer and understands their current and future needs better. This participant is specifically important if participants from the company's environment are not involved or if the one customer's perspective is not considered to be sufficient in order to understand the customer needs.

Each participant is prior to the workshop responsible for conducting an analysis of the surrounding environment of its department. This can be done through the use of for example trend-analysis or external analysis and should be performed in consensus with the participant's team or department to validate the reflections.

Main

The input of the workshop will consist of each participant's knowledge and their prior research and analysis. The leaders of the workshop are responsible for managing the structure of the workshop and taking the participants through the process. The workshop should involve the following activities:

- The leaders present the scenario method and the purpose, time horizon and agenda for the workshop.
- The leaders organize a creative exercise of choice to induce the creativity of the participants and make them let go of their limitations.
- Discussions are held concerning future developments of political, economic, social, technological and environmental aspects.
- Through further discussion two axes are determined which are identified to represent the two most important drivers for the future.
- The main thoughts discussed concerning each scenario made up by the four quadrants are determined and noted down.
- The participants are divided into four groups to further develop one of the scenarios each. A picture representing the future state and fitting name should be determined by each group as well as a short painting description and specific facts of the scenario.
- Presentations are held by each group presenting the scenario, which opens up for more discussion and adjustments to the scenarios. At this point changes must be made based on consenting decisions.

The output of the workshop will be the axes and the description and information determined for each scenario.

Post

At least one of the leaders of the workshop are responsible for creating graphic scenario visualizations of each scenario developed during the workshop. The scenario visualizations should entail the axes, the name, the painting description and a fact box with more specific details of the scenario. Most importantly the scenario visualizations must entail images with a color scheme and objectives which reflect the impression and intention of each scenario. These scenario visualizations can then be communicated within the company and preferably even put up as posters in the company's different communal areas for coffee and lunch to remind the employees what futures the company is working towards.

The information from the workshop and the resulting scenario visualizations should be communicated by the participants of the workshop to their departments and teams and published through the company's internal communication channels. The strategies that the company will develop should be based on the information from the scenarios and therefore the employees will know the intent behind the strategies as they receive them. This way the employees will be made aware of the result of the workshop in all parts of the company while those departments and teams that are most affected are participating in the workshop themselves and can communicate the information directly to their associated area. To process the result of the workshop different ways of application is recommended for various purposes. Presented below are three suggested ways of how the output from the workshop should serve as input to other activities:

Application of images of the future in the corporate strategy: The person from the strategic department is responsible for presenting the scenarios for the team who sets the corporate strategy. A suiting approach for processing the images is by performing backcasting on each scenario. This is a top-down approach where one starts at the given future state working towards the present, creating paths the company can take to reach the future from where they are at this moment. This leads to an action plan for reaching each separate vision of the future which in turn can be compared and compiled with roadmaps and other outcomes from business strategy tools.

Application of images of the future as initiator role in innovation processes: The person from the early stages of the fuzzy-front-end is responsible for presenting the scenarios for the team creating the firm's upcoming concepts or components. The scenarios should be used as the basis of an idea generating where the participants are asked to deliver ideas of attributes, products or concepts that would fit in the corresponding future setting. By letting the scenarios guide the brainstorm, ideas of higher quantity and quality are derived. Furthermore, new customer needs, emerging technologies and competitors' concepts can be found supporting the radical innovations of the company.

Application of images of the future as opponent role in innovation processes: The persons active inside the different phases of the innovation process are responsible for presenting the scenarios for their teams. Preferably during the first meeting with the whole team after the workshop has been held. After this they should all reflect on how the product would perform in the different possible futures. This provides the team with a chance to explore the disruptive potential of their innovation and scan areas that would otherwise be unobserved. Furthermore, by initiating a futures scenario point on the agenda of the gate meetings the teams have the chance to present pros and cons of their current development with regard to the different future scenarios. By discussing the fit and possible changes they are able to challenge the basic assumptions, ensure state-of-the-art projects and thus support the company's incremental innovations. This approach should be taken by every team in the fuzzy-front-end, development and maintenance.

8. Future Research

The agenda for future research concerning the area of futures studies in innovation processes can take many interesting directions. One of which would be to conduct tests and evaluate the process of the recommendation delivered in this study. This would preferably focus on the practical application of the method and develop it further to facilitate its introduction to organizations. It would also be interesting to investigate whether this approach could be extended and applied in other parts of an organization such as sales and marketing etc. Since the empirical findings of this study demonstrates that often there are different perspectives in different departments, scenarios might possess the ability of aligning departments.

Further, it would be interesting to investigate the same area in the setting of another industry. This could possibly increase the scope of the recommendation and contribute to understanding if certain aspects are more relevant for specific industries. Finally, this study examines the impact futures studies have on innovation processes, it would be interesting to investigate whether elements or activities of innovation could contribute with similar effects if embodied in futures studies.

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Appendix 1 – Interview Guide

Background

- What is your role and your main tasks and responsibilities?
- How long have you been working here?
- What part or specific product are you working on?

Innovation Processes

- What does innovation mean to you?
- What does the product development process look like in your company?
- How and where does new ideas arise within the company and how do you take care of them?
 - How are they communicated within the company and who decides whether the idea should be proceeded with?
 - What are the criteria for the selection?
- What do you do with ideas that do not qualify?
- Have you divided the product development into different parts within the company?
 - How is this represented in the organizational structure?
- Do you work with sequential steps or in a more iterative way in your product development?
 - Are your methods and processes based on any specific theory concerning product development?
 - If not, what activities are involved and at what stage?
 - What competences are included in the steps and activities you carry out?
 - Do you have any cooperation with any other department within the company in order to exchange knowledge and information?
 - Are external employees or partners involved in these activities in any way?
 - Does this vary between different product development processes or departments?

Futures Studies

- What does studying the future mean to you?
- How does your company plan for the future?
 - What methods do you use to come up with these plans?
 - What methods or techniques do you use to explore the different possibilities of the future?
 - Where in the company do you do this?
- Have you heard of Scenarios as a method for exploring various possible future conditions?
- Does the company use such activities?
 - Where?
 - Where do you think they would benefit the company the most?

Company Environment

- How do you collaborate with your customers?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?
- How do you collaborate with your suppliers?
 - Feedback / new ideas?

- Exchange of information and knowledge?
 - Where, when, how?
- How do you interact with your competitors?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?

Company Internal knowledge sharing

- Do you believe the company vision is clearly communicated throughout the company?
 - Do you feel everyone is working along / towards it?
- Is the exchange of information encouraged?
- How is your cross-functional work organized?
- Do you have any kind of internal competition?
- How does your company view the use of resources for R&D?
 - What is the company's main purpose with investments in R&D? Good products or learning?
- What happens if a project fails?
- In what parts of the company do you work with innovation?
 - What is the organizational structure for these parts?
- Do you see any value in collaborating more or in a different way with both internal and external parties?
 - If so, who would these parties be?
 - What would be the benefits and risks?

Appendix 2 – Interview Guide Company Trucks

Background

- What is your role and your main tasks and responsibilities?
- How long have you been working here?
- What part or specific product are you working on?

Innovation Processes

- What does innovation mean to you?
- How and where does new ideas arise within the company and how do you take care of them?
 - How are they communicated within the company and who decides whether the idea should be proceeded with?
 - What are the criteria for the selection?
- What do you do with ideas that do not qualify?
- What different competences are present in your team?
- Are there any specific departments you are in close contact with?
 - Which department within the company do you have the most contact with?
- Are any of your partners or employees from other departments involved in any of the activities you carry out?

Futures Studies

- What does studying the future mean to you?
- How does your company plan for the future?
 - What methods do you use to come up with these plans?
 - Are you planning for one desired future or several possible ones?
 - Where in the company do these happen, and what competences are included in the activity?
 - How are these visions communicated further within the company?
- Have you heard of Scenarios as a method for exploring various possible future conditions?
- Does the company use such activities?
 - Where?
 - Where do you think they would benefit the company the most?

Company Environment

- Do you collaborate with customers in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?
- Do you collaborate with suppliers in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?
- Do you integrate with competitors in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?

- Do you see any value in collaborating more or in a different way with both internal and external parties?
 - If so, who would these parties be?
 - What would be the benefits and risks?

Company Internal knowledge sharing

- What is the company vision?
 - Do you believe the company vision is clearly communicated throughout the company?
 - Do you feel everyone is working along / towards it?
- Is the exchange of information encouraged?
 - If you need help, do you know who to ask and are these people easily accessible for you?
 - Are there any common areas for lunch or coffee breaks?
- How is your cross-functional work organized?
 - Between different departments?
 - In what way? Meetings, email, etc?
 - How often?
- Do you have any kind of internal competition?
 - Where does this occur and between whom?
- How does your company view the use of resources for R&D, is the main purpose good products or learning?
- What happens if a project fails?

Appendix 3 – Interview Guide Company Cars

Background

- What is your role and your main tasks and responsibilities?
- How long have you been working here?
- What part or specific product are you working on?

Innovation Processes

- What does innovation mean to you?
- What does the product development process look like in your company?
 - What different phases are involved?
 - How is this divided organizationally?
- Do you work with sequential steps or in a more iterative way in your product development?
 - Does this vary between different product development processes or departments?
- How and where does new ideas arise within the company and how do you take care of them?
 - How are they communicated within the company and who decides whether the idea should be proceeded with?
 - What are the criteria for the selection?
- What do you do with ideas that do not qualify?
- What different competences are present in your team?
- Are there any specific departments you are in close contact with?
 - Which department within the company do you have the most contact with?
- Are any of your partners or employees from other departments involved in any of the activities you carry out?

Futures Studies

- What does studying the future mean to you?
- How does your company plan for the future?
 - What methods do you use to come up with these plans?
 - Are you planning for one desired future or several possible ones?
 - Where in the company do these happen, and what competences are included in the activity?
 - How are these visions communicated further within the company
- Have you heard of Scenarios as a method for exploring various possible future conditions?
- Does the company use such activities?
 - Where?
 - Where do you think they would benefit the company the most?

Company Environment

- Do you collaborate with customers in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?
- Do you collaborate with suppliers in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?

- Where, when, how?
- Do you integrate with competitors in your work?
 - Feedback / new ideas?
 - Exchange of information and knowledge?
 - Where, when, how?
- Do you see any value in collaborating more or in a different way with both internal and external parties?
 - If so, who would these parties be?
 - What would be the benefits and risks?

Company Internal knowledge sharing

- What is the company vision?
 - Do you believe the company vision is clearly communicated throughout the company?
 - Do you feel everyone is working along / towards it?
- Is the exchange of information encouraged?
 - If you need help, do you know who to ask and are these people easily accessible for you?
 - Are there any common areas for lunch or coffee breaks?
- How is your cross-functional work organized?
 - Between different departments?
 - In what way? Meetings, email, etc?
 - How often?
- Do you have any kind of internal competition?
 - Where does this occur and between whom?
- How does your company view the use of resources for R&D, is the main purpose good products or learning?
- What happens if a project fails?