Success factors, challenges and Problems during external technology exploitation of an R&D Company

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Abstract

Several divisions in the process industry are facing numerous challenges due to changes in the process industry landscape. Factors related to the recession, climate change and an increasing competition have left its mark. Consequently, there are several units within the process industry that seeks other opportunities in order to extend their expertise and develop innovative technologies in new landscapes within the process industry. As it has been increasingly prevalent for companies to participate in a partnership with external actors in order to develop and commercialize new innovative products and solutions, it is still a rather complex process and has insufficiently been reflected upon in academic studies.

The aim of this master's thesis is therefore to investigate and analyze what challenges and problems R&D companies within the process industry faces when entering an alliance/partnership for external technology exploitation, and also identify success factors. The master's thesis is delimited to the planning phase of a project as it was identified as the most crucial phase. The purpose is to allow companies adjust their strategy more efficiently and competently when knowing what the potential problems and challenges are, thus providing results that would be of great practical use for R&D companies overall. The master's thesis was conducted by a qualitative approach, interviewing two dozen key persons and in-depth investigation of a project. Triangulation methods was employed in order to verify and strengthen the gathered data from the interviews, and analyzed in relation with literature. We have identified 11 challenges and problems an R&D company could experience, such as risks related to coordination requirements, partner selection, planning tools etc. However, there are also 15 of success factors an R&D company should contemplate upon, such as potential synergies between small inventions in order to utilize and attain a larger combined effect, and designing a strategic partner selection process.

Sammanfattning

Flera divisioner inom processindustrin står inför många utmaningar på grund av förändringar i processindustrins landskap. Faktorer relaterade till lågkonjunkturen, klimatförändringar och ökad konkurrens har satt sina spår. Följaktligen finns det flera enheter inom processindustrin som söker andra möjligheter för att bredda sin kompetens och utveckla innovativ teknik i nya landskap inom processindustrin. Eftersom det har blivit allt vanligare för företag att delta i ett partnerskap med externa aktörer för att utveckla och kommersialisera nya innovativa teknologier och lösningar, är det fortfarande en ganska komplicerad process och har inte heller tillräckligt avspeglats på i akademiska studier.

Målet med detta examensarbete är att undersöka och analysera vilka utmaningar och problem som FoU-företag inom processindustrin står inför vid bildandet av allians/partnerskap för extern teknologi exploatering, och även identifiera framgångsfaktorer. Examensarbetet avgränsas till planeringsfasen av ett projekt eftersom den har identifierats som den mest avgörande fasen. Syftet är att förse FoU-företag med insikt om de potentiella problem och utmaningar som kan uppstå och därmed kunna anpassa sin strategi mer effektivt. Examensarbetet genomfördes med en kvalitativ metodgång där två dussin nyckelpersoner från företag i process industrin intervjuades, och även en fördjupad undersökning av ett projekt. Trianguleringsmetoder utnyttjades för att kontrollera och stärka insamlad data från intervjuer, och därefter analyserades i samband med en litteraturstudie. Vi har i undersökningen kommit till underfund till 11 utmaningar och problem ett FoU-företag kan uppleva, till exempel risker relaterade till kraven på samordning, partner-val och planeringsverktyg etc. Vi har även identifierat 15 framgångsfaktorer ett FoU-företag bör överväga att implementera, såsom potentiella synergier mellan mindre teknologier och innovationer för att framhäva en mer betydande kombinerad effekt, och en strategisk parter urvalsprocess.

Nyckelord
Extern exploatering av teknik, planering, processindustri, innovation, pre-kommersialisering.

Key-words
External technology exploitation, planning, process industry, innovation, pre-commercialization.

Foreword

This thesis is written as completion to the master degree in Industrial Economics and management in the Royal Institute of Technology (KTH) in Sweden. The work was conducted between January and June 2014 with the help of Innventia, an R&D company within the process industry. During the master's programme and degree project, a vast variety of valuable knowledge was attained and applied to shape this thesis upon, and hopefully also our future.

Firstly, we would like to thank our supervisor Michael Novotny for the great guidance. We would also like to express gratitude and appreciation to Tom Lindström at Innventia who provided us with the opportunity to this master's thesis, and the personnel at Innventia that provided us with insights and knowledge necessary to conduct this thesis. We also would like to offer our gratitude to all whom we interviewed and contributed with knowledge from the variety of organizations and companies related to the process industry.

Finally, we would like to thank KTH the head of the programme at Industrial Economics and management with this great education.

Stockholm, 9 June, 2014.
Saif Khalil
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1 Introduction

This introduction chapter is aimed to provide the reader with a conceptual understanding on what this master's thesis is about. The first part of this chapter will provide a background to the research of this master's thesis. The second subchapter will elaborate on the main subjects related to the problem statement. The third subchapter will introduce the problem statement, followed by consecutive subchapters regarding the thesis purpose and aim, research questions and delimitations of this thesis. The last subchapter will provide a brief overview of the project outline.

1.1 Background

Several crucial experiences and events have affected the world during the 21th century. One of them being the great recession, which toppled many industries and world economies. Another one being the climate change and the growing concerns about the use of fossil fuels and emissions, leading to an increasing international interest in developing and utilizing sustainable solutions to minimize environmental impact. Consequently, the process industry is facing a progressively more competitive environment as we move into the 21th century, and seeks opportunities in order to compensate for the falling demand due to not only the global regression, but also changes in the process industry landscape (Kumbhare, 2009). Such changes is for example related to the seemingly never ending decline in the demand of paper, suggesting that the industry is becoming increasingly unstable (Zara, 2012; Irwin, 2013). R&D units in the process industry are transforming and searching for new paths and landscapes, developing innovative and sustainable solutions in order to compensate for the changing demand. As the exploitation and commercialization of such innovation is rather complex, many organizations collaborates with other businesses in order to benefit from external capabilities (Lichtenthaler & Ernst, 2007; Mitchell & Singh, 1996). According to Lichtenthaler & Ernst (2007), it has recently become an increasingly broader trend where companies utilize external technology exploitation in order to commercialize their technology and innovations externally. However, this process is rather complex and has insufficiently been reflected upon in academic studies (Lichtenthaler & Ernst, 2007).

1.2 Problem discussion

Since two decades ago, technology transactions have been increasing rapidly. This is because several industrial companies begun to actively collaborate and use external acquisition of technologies and knowledge as a part of business approach and strategy (Grandstrand et al., 1992). The use of internal and external sources in order to develop and exploit new technologies has allowed companies to gain a competitive advantage, and is viewed today as important in order to survive in today's market

(Zahra and Nielsen, 2002). According to Kline (2003) and Lichtenthaler (2005), there are few companies that have succeeded in gaining noteworthy benefits by externally exploiting technology or knowledge assets due to certain difficulties related to the process. Knowledge imperfections in markets are partly a reason, which indicates that the ability of external exploitation of technology and knowledge has to be developed and managed more efficiently. External exploitation of technology & knowledge has to be considered as a part of a company's business strategy rather than just an activity without pro-activeness (Kutvonen, Torkkeli & Lin, 2010). Furthermore, as stated earlier the process of external technology exploitation is rather complex and has insufficiently been reflected upon in academic studies (Lichtenthaler & Ernst, 2007).

1.3 Problem statement

The development and exploitation of new innovative products and technologies in R&D companies require external funding and/or collaborative support by value chains with several actors, which deem the innovation process with several actors of innovation to be large and complex. As the five main phases for external technology exploitation according to Lichtenthaler (2007) is planning, intelligence, negotiation, realization and control, only three are actually in a pre-commercialization stage. This thesis will though investigate only the planning phase, one of the core critical factors in a pre-commercialization phase (See chapter 1.6 and 1.7 for clarification). Thereby the problem formulation is -

> *What are the potential success factors- and what are the challenges & problems that could occur for a R&D company during a technology pre-commercializing planning phase when forming an alliance/partnership for external technology exploitation?*

1.4 Thesis purpose and aim

The aim of this master's thesis project is to investigate and analyze what challenges and problems R&D companies' faces in a planning phase when entering an alliance/partnership for external technology exploitation, thereby also identify certain success factors. The purpose is by acknowledging the challenges and problems R&D companies possibly could experience, R&D companies would be allowed to adjust their strategies based on those potential challenges and problems that could occur in a planning phase. Furthermore, the most critical aspects in a planning phase could be managed more efficiently prior of instituting a partnership when knowing what the potential problems that could arise are. The provided success factors will also contribute for a more efficiently managed planning process. The thesis will have an academic context throughout the whole report, and

simultaneously provide results that would be of great practical use for R&D companies overall.

1.5 Research questions

- What are the challenges & problems in a planning phase that could occur for an R&D company during external technology commercialization?
    - Identify and analyze the critical factors.
- How could a R&D company potentially overcome challenges & problems in a planning phase during external technology commercialization?
    - Identify and analyze the success factors.

1.6 Pre-commercialization

Through a large empirical study of 152 industrial companies in Europe and a theoretical study, Lichthenthaler (2007) identified and synthesized a five step process model related to the process of external technology exploitation with the steps; planning, intelligence, negotiation, realization and control. This thesis will employ a specific part of the five step model for a more in depth research. The five step model includes phases exclusively used in pre-commercialization. The definition of pre-commercialization is stated by Kutvonen, Torkelli & Lin (2010) as the range of activities that are aimed towards successful commercialization (internally or externally) of a technology or knowledge asset. The significant notion here is that the phase is prior to the actual commercialization phase, and include important elements in studies of technology viability and initiation, target/goal setting, contact with clients and partner selection, organizational and strategic stages engaged with the aim of securing successful commercialization, road-mapping, etc.

1.7 Delimitations

The focus of this thesis will be to investigate what eventual challenges and problems are from the perspective of an R&D company/institute/department (etc.) in the process industry, and how they can be solved, rather than an in-depth analysis and/or investigation if the proposed implementations are actually viable financially from an organizational perspective. This thesis will in the coming chapters mostly employ the use of the term 'R&D Company' for lucidity and simplicity reasons, therefore R&D institutes/departments etc., are not delimited. All the pre-commercialization phases plays a critical role in the success of a collaboration for external exploitation of innovation, however, the determinants of external exploitation success is according to Kutvonen, Torkkeli & Lin (2010) especially in the

phases of planning, negotiation and control, of which only planning and control are pre-commercialization activities. The control phase is though a mix between activities falling in and out of scope of a pre-commercialization stage (Kutvonen, Torkkeli & Lin, 2010), leaving only the planning phase as the pure determinant and critical core phase in pre-commercialization activities. Furthermore, despite the many opportunities of external technology exploitation and commercialization, there are high risks that require thorough strategic planning and analysis (Lichtenthaler, 2008). Thereby, the problem statement and research questions are delimited to only regard the planning phase in the five step model, thus other phases and also potential models of similar sort is not accounted for. The planning phase employed in this thesis is also strongly related to a functional perspective. The individual and organizational perspective might occur, but in minor detail and not explicitly, however the background is heavily related to an organizational perspective.

1.8 Significance

This thesis will benefit R&D companies/departments/institutes in the process industry that aims to join a partnership and collaborate with other external actors (R&D and/or non-R&D) in order to develop a certain technology, thus the definition 'external technology exploitation'. The pre-commercialization activities during external technology exploitation are according to Kutvonen et al. (2010) always the responsibility of the developer of the technology, denoting the importance of R&D companies to actively engage in the process. External technology exploitation for R&D companies doesn't necessarily mean that R&D Companies actively pursuit commercialization opportunities for their technology with external actors. External technology exploitation could very well have the purpose of attaining new opportunities for new externally initiated projects by being part of innovation clusters and collaborating with partners that aims to commercialize new technology, implying that an R&D company doesn't have to commercialize the product themselves but rather being a part of the development process and let external actors handle the commercialization. This thesis will therefore benefit R&D companies engaged in such process by shedding light on the success factors, problems and challenges in order for them to address.

1.9 Project outline

Chapter 2 – Methodology

In this chapter, the methodology and corresponding methods used are explained. The methodological approach emphasizes on the use of case study, interviews and theoretical framework.

Chapter 3 – Theoretical background

The theoretical segment of this thesis is structured upon two chapters, the theoretical background and theoretical framework. The first chapter provides an underpinning for the specific theories used later on in the theoretical framework in chapter 4. In this theoretical background chapter, a review of literature general models and theories related to this thesis will elaborate upon.

Chapter 4 – Theoretical framework

In this chapter, a review of explicitly used theories and models will be presented.

Chapter 5 – The Case study

This chapter will introduce a short summary of the project investigated during this research as a part of research phase 3.

Chapter 6 – Empirical results and Analysis

This section presents an analysis of the obtained results. The section is structured in accordance with the major segments related to in a pre-commercialization planning phase.

Chapter 7 – Conclusion

In order to provide conclusions based on the research questions, in this chapter the main outcomes of the study are summarized and presented.

2 Methodology

The methodology in academic reports aims to provide the readers with a thorough description on what and why specific methods are used to collect necessary data to an article/thesis/report (Collis and Hussey, 2009). Due to the nature of the report being centered around a specific category of companies with an empirical inquiry on a specific contemporary phenomenon, this study can generally be regarded as a case research. To depict a necessary methodical approach and enhance the overall quality of this report, this master's thesis has been conducted and reviewed in a way in order to achieve a valid conclusion. The main aim of this chapter is to explain the specific methods used when collecting necessary data and empirical information. However, the first and second sub-chapters are intended to classify the report and briefly elaborate on the case study approach in order to provide underpinning for the methodology to be built upon. The following subchapter will emphasize on the case process and related interview and literature study execution. The last subsections present a quality discussion of the report.

2.1 Classifying the report

Generally, reports is classified as exploratory, descriptive, analytical or predictive (Collis and Hussey, 2009; Andersen, 1998). Exploratory research is used to investigate and obtain insights in a phenomenon; descriptive to describe a phenomenon as it currently is; analytical to analyze and understand a phenomenon; predictive to predict how or if a phenomenon is going to happen (Collis and Hussey, 2009). This report could be classified as exploratory and/or analytical according to its purpose. As the objective of this report is to investigate what eventual challenges and problems are from the perspective of an R&D company, thus also why they occur and how they can be solved, it has an exploratory nature, and will therefore employ a qualitative approach. However, the purpose is also of an analytical nature as the ambition is to establish a relationship between the occurring challenges and problems, and the success factors. Analytical reports usually provide answers to 'how' and 'why' questions, which this report accordingly do (Collis and Hussey, 2009; Yin, 2009).

2.2 Case study

Case study is a suitable methodology to this report because it is commonly used when exploring phenomenon(s) using on or more different methods to obtain detailed and deep knowledge on a certain subject (Collis and Hussey, 2009). Since this study will be based on a unit of analysis, it could be described as a *case study*. The context is vital and gathering data and extensive background information about the

case is therefore important to be able to make an analysis (Collis & Hussey, 2009). As the authors have no control of events of neither the phenomenon nor the affected companies, a case study is a suitable approach Furthermore, a case study could theoretically include several cases, and will in this study include only one (Collis and Hussey, 2009).

It has been taken into consideration that case studies are often somewhat biased from the authors' own opinion (Yin, 2009), and therefore it may be difficult to draw general conclusions from the report. Andersen (1998) argues that case studies as the methodology approach might yield reports with lower validity, but by analyzing interviews as objectively as possible in cohesion with a literature study, it will be strengthened. The authors are also aware that interviews in case studies might be highly time-consuming (Collis and Hussey, 2009), but have taken careful measures in order to prevent inefficient time bleed. To obtain a deep and detailed analysis of the explored phenomenon, the report's analysis will be of a qualitative nature in accordance to (Collis and Hussey, 2009). In addition, and to obtain in-depth knowledge, the data collection includes detailed information from face to- face interviews if possible, and phone interviews as final recourse. Obtaining this detailed data should help later in the analytical process of the report and could even increase the understanding of the phenomenon according to Holme et al. (1997). To obtain the data, there has been a usage of qualitative, semi-structured interviews and analysis of documents/articles related to the case. Instead of having a rigorous set of questions, the semi-structured interviews was made to be open and conversational, allowing new ideas to be promoted and discussed during the course of the interview.

2.3 Triangulation

Triangulation basically means using multiple sources of data, methods, and/or more than one researcher to investigate a certain phenomenon and increase the strength of the research (Collis and Hussey, 2009). As there are different types of triangulation methods, this report uses methodological triangulation and data triangulation. Methodological triangulation implies that more than one method is used to collect and analyze the data (Easterby-Smith, Thorpe & Lowe, 1991). Relating to this thesis, methodological triangulation is used by executing a case study, qualitative interviews and a literature study in order to investigate a certain set of questions. Data triangulation is when data are collected at different times or from different persons in the same study (Easterby-Smith, Thorpe & Lowe, 1991). Throughout the case study, data is collected using interviews with key persons related to the case, and analyzing documents/reports related to the case, thus fulfilling the data triangulation. Furthermore, the interviews that are not related to the project (See chapter 2.4) in the case study have also been carried out with similar data triangulation approach where different persons from same company were interviewed with a similar set of questions at different time.

The interviews with key persons in similar field (e.g. process industry) but not related to the actual project of the case study has been performed in order to further strengthen the research and the obtained results. The literature review serves as a contextual relation to cases, theories, and models in a planning phase that has been studied in previous research. By employing the use of these methods, the investigation can obtain qualitative, extensive information and detailed results that's been triangulated from different sources and methods. The aim of this multiple approach is to give the study a richer view and strengthen the understanding of the results. Using more than one method to collect data can give the report an enhanced view of the studied phenomenon (Collis and Hussey, 2009; Webb et al., 1966). Triangulation can also reduce bias from the report's authors, data sources and methods, and also allows the phenomenon to be approached from different perspectives and/or through different stakeholders (Collis and Hussey, 2009).

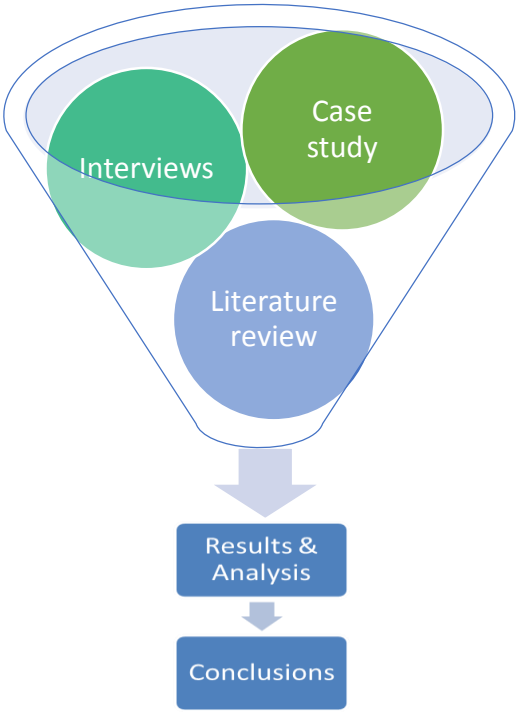

Figure 1. A presentation of the triangulation approach and workflow

2.4 Investigation process

The investigation process will be explained in two parts. The first part focuses on the pre-study and initial progress of the thesis and is very important to elaborate upon due to certain realization in the pre-study which formed the structure of this thesis later on. The second part will elaborate on the three phases of the actual study, and covers the case study, interview- and literature study/execution after the pre-study.

2.4.1 Part 1: Pre-Study

This master thesis is initially instigated by Innventia, a research and development in company in the process industry that works with innovations based on raw forest materials, bio-refinery, pulp etc. However, the thesis was progressed and performed as an entirely independent academic study. The process industry is a branch of industries working with recipes and formulas in developing/ manufacturing products/technologies related to bio-refinery, chemicals, beverage, drugs and pharmaceuticals, textiles etc. A company such as Innventia is therefore a typical company in the process industry. As Innventia is to an extent reliant on external support and collaboration with other institutes/firms, the initial notion that caught the company's attention was the recent establishment of the Bioplastic Feedstock Alliance (BFA) that included large firms with the aim to guide and encourage sustainable plant based plastics. As one of the world leaders in R&D in environmentally friendly packaging materials, Innventia is interested in catalyzing the potential market for sustainable biodegradable packaging materials for food by using its expertise in various bio-based packaging materials. The interest from Innventia's perspective was to investigate how to realize a partnership and support of such alliances in order to further develop sustainable packaging solutions (external technology exploitation), and thus also explore the purpose of BFA.

A pre-study was performed that mainly consisted of open interviews with key persons at Innventia and also a literature study. As this master thesis is conducted in the field of industrial management, the pre-study was conducted mainly as a literature study in fields related to management theories in order elucidate on an appropriate problem formulation suitable for an academic master thesis in industrial management, and simultaneously in interest for a company such as Innventia. The purpose of the pre-study was also to plan on how to progress with the thesis and set up preliminary deadlines.

The pre-study indicated that the development and exploitation of new innovative biodegradable packaging solutions requires funding's of and support by external institutions and companies, and involves certain processes and essential elements within those processes in order to proceed efficiently. As a result of a declining market, companies within the processing industry are looking for new applications and markets for their technologies, production capacity and competence. The industry has turned their attention to new types of material which generally has a higher profit margin. Outcomes from the open interviews indicated that a major challenge to create partnerships with the processing industry by finding product application for new materials is that the knowledge and competence about material science is generally very low, and it is therefore difficult for these companies to make investments.

Large multinational chemical companies and R&D departments are financially very strong which could create an even higher barrier to overcome for a smaller R&D company trying to find new market opportunities. The processing industry has historically never been subject to a highly competitive market. Combined with extensive technological and economic lifecycles technology has been push out to the market instead of a market pull strategy. A turbulent market environment has put transformation pressure on the industry to change. Based on the challenges Innventia is facing, and R&D companies overall, the problem formulation was specified in order to be mainly related to external technology commercialization in a pre-commercialization stage. The problem formulation and spectrum were widened to include and able to be proposed for a wider range of R&D companies/institutes and departments, but limited only to the first stage in external technology commercialization, the planning phase, thus the current problem proposition –

> *What are the potential success factors- and what are the challenges & problems that could occur for a R&D company during a technology pre-commercializing planning phase when forming an alliance/partnership for external technology exploitation?*

Furthermore, the pre-study included discussions with employees at Innventia, a supervisor and a professor at the university in order to form a proper outline of research questions and delimit the problem formulation. The interview questions were later on formed based on the research questions and problem formulation, and inspired by the literature study. Concurrently as the interview sessions, the theoretical framework was supplemented by literature in order to appropriately understand the empirical results.

2.4.2 Part 2: Three phases of research

The research conduct process after the pre-study can be divided into three main phases. The first phase included a period of short-term literature study and information gathering in the form of open interviews in order to gain greater insight into the problem area and solidify the research. The information gathered from these interviews was analyzed and used to go into greater depth in the semi-structured follow-up interviews. The interviewees were chosen based on their position and experience in the company, and knowledge and position within the problem subject and case, thereof attaining a more valid and larger spectrum of information for the authors to analyze.

The second phase of the research conduct included a more widened literature study and extended semi-structured interviews with representatives for a variety of companies in order to gain a wider understanding of their work process. Documents related to the case study were gathered, and the data collected from the interviews

in the first and second phase, along with the literature study was analyzed in order to find common patterns and create an outline for the results.

In the third phase, a final iteration of semi-structures interviews was held with key persons in a project at Innventia, related here as the case study. Important details from the planning phase of that project were also gathered from provided documents and reports about how the project was conducted, what the achieved results were etc. Such approach could be regarded as a more in depth study of real-life project, supporting the triangulation approach and case conduct, thus attaining greater insight of the problem and solidifying the results. All the gathered data was thoroughly analyzed in order to capture solid conclusions and provide recommendations based on the problem formulation.

Figure 2. The three phase of the research

To conclude, the results and analysis will be based on the project of the case study, the qualitative interviews in research phase 2, and the literature study (research phase 1) which has been ongoing throughout the whole study. Those phases will all support each other in order for this study to realize common denominators and provide solid conclusions. As the vast majority of the interviewees of research phase 2 are major actors that have cooperated and some are today cooperating with Innventia (i.e. Project of the case study and other projects), it is very important to investigate their approach as the whole process entails around partnership and cooperation, and could very well affect current and future partnerships. As the core part of Innventia's operations is collaborative cluster research in which industrial companies from all over the world collaborate (Innventia, n.d), the project itself is typical for a company such as Innventia and listed among other typical and similar research projects in Innventia's webpage.

2.5 Literature study

A literature study has been ongoing throughout the whole process by investigating different types of collaboration, planning theories, and general articles about R&D, innovation etc. The ongoing literature study was carried in order to prevent unnecessary work that is common when having a literature study only in the first phase. This approach will lead to the acquirement of relevant information collected at the time needed. The literature study will support the main proposition of the thesis and to broaden its base. The literature entailed mostly around articles, e-books, physical books and thesis. The theoretical section of this thesis is divided into two parts, were the first part isn't necessarily and explicitly linked to the results in the results and analysis chapter, but rather more to provide a better base of understanding for the reader by establishing an underpinning of major theories related to the topic of this study. The second part is more specific on certain models related to the results. All articles are thoroughly examined based on appropriateness and quality. The referenced articles in the results and analysis chapter are also of very high standards and generalizability due to their great methodological approach, large sampling and systematic investigation. The literature were mainly found using different types of search engines such as the one provided by the Royal Institute of Technology (KTHB Primo), the library of KTH, Stockholm public library and Google scholar.

2.6 Performing the Interviews

Several interviews have been conducted with the identified core actors both externally and internally. The aim of the first interviews was to capture the background to the problem and gain insights for possible ways to proceed with further interviews. General information about Innventia, their technology and expertise was acquired by weekly meetings with the supervisor and internal interviews/discussions. This part is mainly related to the pre-study, and because those interviews do not having anything with the actual research and achieved results to do, they will not be accounted for in the results and interview summary, see table 1.

For the actual research, this master thesis mostly employed the use of semi-structured interviews. Interviews are generally divided into structured, semi-structured and unstructured interviews. The unstructured and semi-structured interviews is employed if the aim is to comprehend the thoughts of the interviewee by allowing new questions being brought up during the interview based on what the interviewee says, while structured interviews is the opposite and does not allow one to divert form the pre-set of questions. The structure of the interviews is therefore very important and has to be suitable according to the purpose of the research (Patton, 2002).

Interviewing is a method mainly for collecting primary data. It is defined as one or more persons (interviewers) asking questions to one or more persons (interviewees) to find out what the interviewees think, do or feel about a specific topic (Collis and Hussey, 2009). To enhance the collection of data from the interviews, questions were prepared in advance. As it is important to consider that the conversational environment might change during the course of the interviews, some questions were kept fully open (Collis and Hussey, 2009). In accordance with Weiss (1995), by doing this the interviewees had a chance to prepare for the questions and still give an open but opinionated answer. As an interviewee shares sensitive data and life experiences, it is important as an interviewer to stay open-minded and listen (Kvale et al., 1997). To enhance the depth and enrich the interview, probing questions was used to follow up on received answers (Collis and Hussey, 2009). A few interviews with Innventia were performed and aimed to investigate and confirm that the suggested research path lied in a satisfying direction. The actual interview was semi-structured and held in an open fashion. The interviews were conducted face-to-face in a stable environment, e.g. in their office or by phone. Probing questions were used to enhance the answers, for example “why is it like this?" and “could you develop it in more detail?". The interviews were documented to ensure that the gathered data was interpreted correctly.

It is very important to shape the interview guide in a timely manner and get the respondent to feel safe and additionally self-prepare themselves in advance. Starting with a series of simple and general questions is beneficial. Many other various and varied factors also play a role during the interview. It can be anything from where you sit to important security factors, such as helping familiarize himself with the interview guide in order to feel secure in the situation, and thereby also convey the feeling of security. Furthermore, it is important to plan the interview, know how things are going to act if the interview is not progressing as planned and be able to steer the conversation well. All of this has been observed in these interviews to the most convenient way to reach the sought. In order to create guidelines for how the interviews are to be held, a set of quality criteria’s studied from Kvale (1997):

- The extent of spontaneous, rich, specific and relevant answers from the interviewee.
- The shorter interview questions and extended interview answers, the better.
- The degree to which the interviewer follows up and clarifies the meaning of the relevant aspects of the responses.
- The ideal interview is interpreted extensively over the course of the interview.
- The interviewer tries to verify his interpretations of the interviewee's answers during the interview processes

- The interview is "self-communicating" - it is a story in itself that hardly requires much extra descriptions and explanations.

The interviews were for the most part conducted by both authors, were one took a more supportive role. The interviews were recorded and then processed. The authors chose to transcribe all the interviews in order to make it easier to categorize the collected data in appropriate sections and consequently get the interviews more transparent. At this stage, the authors processed and analyzed the interviews in order to realize relevant results based on the empirical study and theoretical framework.

2.7 Forming the Interview template

This research used two interview templates, the first one is for the qualitative interviews in research phase 2 that are not related to the case study, and the second one only for the four key persons interviewed in the case study during research phase 3. The first interview template was inspired by the 'five step process model' as rendered and reviewed in the article "Pre-commercialization activities in external exploitation technology" by Kutvonen, Torkkeli & Lin (2010). The article describes the process of external exploitation of technology based on research performed by Lichtenthaler (2007). The frequent propositions in various elements of literature make up the foundation of the five step model, which is translated into iterative phases of: planning, intelligence, negotiation, realization and control.

- The planning phase regards the planning of external technology exploitation and corporate planning processes. Furthermore, the planning refers to a high-quality process of strategic technology planning, target setting, resource allocation and technology customer pre-selection.
- The intelligence phase is about scanning and monitoring the firm's technology environment/market. It also denotes the need identifying prior information need and subsequent evaluation of information and communication.
- The negotiation phase is the contact point with the customer and compromises of negotiations with technology customers. Thus attaining a clearer view of the compatibility with potential technology customer.
- The realization phase refers to the planning of the technology transfer at an operational level and detailed process mapping in order to specify the implementation process with particular attention to potential interface problems and coordination requirements.
- The control phase refers to the identification of information needs information generation, information evaluation and information communication. It also

includes decisions on when the transfer activities are to be redirected and when the process should be terminated.

The five segments was viewed to be suitable as an interview template mainly due to their relevance for the thesis problem formulation and research questions, and it was suitable to initially grasp all phases of the five step model, thus attain necessary knowledge about the whole external commercialization stage. Consequently, several interview questions were formulated based on each phase. Clear definitions of the different phases along with certain key-terms (such as what we mean with external exploitation) were stipulated and defined beforehand in order to clarify for the interviewee when needed. To be noted here is that certain questions under each category could fall under another category.

The second interview template was mainly related and used for the case study conduct for research phase 3, and based only on the planning phase of the five step model. Same questions were used as in the planning phase in the first interview template, however, now with more specific questions added with the aim of also getting explicit answers from key persons in a real-life project/s.

2.8 The interviewees

Sixteen interviews with key persons from a total of eight different companies-/organizations were performed during the research phase 2, see table 1 below. The interviews were conducted face-to-face or by phone, and documented to ensure that the gathered data was interpreted correctly. Due to confidentiality reasons, the specific names of the interviewees and company will not be presented. The interviewees and discussions during the pre-study are excluded in table 1 below, only the interviewees for the actual research is presented. The interviewees during research phase 2 was carefully selected due to their high relevance, depending of factors such as expertise, experience and knowledge linked to the problem statement, and every interviewee knew beforehand exactly what this research was about in order to confirm their relevance. Out of the sixteen interviews in the second research phase, eight were from four different companies, were two persons were interviewed from each of the four companies in order to support the data triangulation approach.

For research phase 3 with the case study approach, four persons were interviewed in order to also support the data triangulation approach. Furthermore, almost all companies are related to the process industry directly in both research phase 2 and 3. Company nr 6 and 10 in table 1 below is though in a gray zone because they do not work with R&D, but rather contribute with knowledge and drive to change governments and industries in working for and developing sustainable solutions,

whether they are in the process industry or not. Nr 8 in table 1 below is a cluster of different companies from the food retail- and paper industry that works with gathering knowledge, expertise, facilities and resources through open innovation in order to contribute for the development of sustainable solutions based on biomass. As with the interviewees, the companies were carefully chosen due to their relation and contribution to the process industry, some of the being internationally acknowledged as core actors in the process industry with tens of thousands of employees, while a few are more linked to the Scandinavian region. They are all critical actors in shaping the future of the process industry, and also actors highly interesting for an R&D company which is actively seeking opportunities of collaboration. See table 1 for a summary of the interviews.

Interviewee	Type of company	Role in company	Interview time	Interview structure	Interview type
Research phase 2 – Qualitative Interviews					
1	R&D, distributor, supplier	Director of technology development	40 min	Semi-Structured	Face-to-face
2	R&D, distributor, supplier	Business Development & Manufacturing Innovation manager	40 min	Semi-Structured	Face-to-face
3	R&D	Director, packaging & logistics	60 min	Semi-Structured	Face-to-face
4	R&D, manufacturing, commercialization	Sales manager	40 min	Semi-Structured	Phone
5	R&D, distributor	Process & Application manager	90 min	Semi-Structured	Face-to-face
6	Non-profit Environmental organization	Manager in Packaging and Material Science	60 min	Semi-Structured	Phone
7	R&D, distributor	Vice President	100 min	Semi-Structured	Face-to-face
8	R&D, Innovation cluster coordinator/Research coordinator	Business development manager	60 min	Semi-Structured	Phone
9	R&D, distributor, retailer	Senior associate principal scientist	115 min	Semi-Structured	Phone
10	Trade association company	Director of research policy	60 min	Semi-Structured	Face-to-face
11	R&D	Director of Innovations	60 min	Semi-Structured	Phone
12	R&D	Market manager and Business developer	60 min	Semi-structured	Face-to-face
13	R&D	Senior advisor of business and innovation	60 min	Semi-structured	Face-to-face

14	R&D	Project Coordinator/manager	40 min	Semi-structured	Face-to-face
15	R&D	Project manager	45 min	Semi-structured	Face-to-face
16	R&D	Project manager	35 min	Semi-structured	Face-to-face
Research phase 3 – Case study					
A	R&D	Senior Research manager	110 min	Semi-structured	Face-to-face
B	R&D	Business developer/Project coordinator	40 min	Semi-structured	Face-to-face
C	R&D	Research manager	35 min	Semi-structured	Face-to-face
D	R&D	Deputy program manager/ Research scientist	35 min	Semi-structured	Face-to-face

Table 1. Summary of the interviews

2.9 Discussion of research credibility

There are several aspects regarding plausibility that has to be taken in consideration when performing a case study. The most important that will be pointed out here are reliability, validity and generalizability.

2.9.1 Reliability

Reliability signifies the absence or presence of variances in the results if the study would be conducted multiple times. A high reliability emphasized for a quantitative approach would simply relate to a higher degree of which a measurement remains the same, along with the stability of the measurement over time, and also the similarity of the measurement during a specific time period (Collins & Hussey, 2009). Therefore, it becomes harder to prove high reliability with a qualitative approach than with a quantitative approach. Methods used in a qualitative approach are simply more subjective. As this master's thesis has been conducted with a qualitative approach based on interviews and case study, the reliability would initially seem to be low. Though, the data will be treated as objectively as possible in the analysis. Further on, the reliability in a research like this emphasizes more on a methodical approach by establishing protocols and processes on how the study is conducted, along with data collection and consistency of data and triangulation to improve the authenticity.

2.9.2 Validity

The validity indicates the extent of which the research findings in the case study accurately reflects and measures what it was proposed to measure and how truthful the results are (Collins & Hussey, 2009). It also concerns other significant aspects such as research errors and inadequate samples, which would undermine the validity (Collins & Hussey, 2009). As this master's thesis seeks to understand a phenomenon in context-specific natural settings in order to make sense of and/or interpret a specific phenomenon, a qualitative approach is most suitable (Guba & Lincoln, 1994; Hoepfl, 1997). The semi-structured interviews will increase the validity because it is possible to ask questions back based on the received answers more liberally and therefore also get a better understanding of the situation and answers perceived. To increase validity in the interviews, a diverse literature study as well as test interviews was performed before constructing the final interview structure. This is done in order to include relevant and unbiased questions in the interviews to increase the validity. Furthermore, several interviews have been repeated with other interviewees at the same company in order to support and strengthen the quality of the research. Along the case study approach and the verified interviews, this study holds high validity.

2.9.3 Generalizability

Generalizability is defined as the extension of which research and conclusions of a study conducted on a sample population are applicable to other subjects. Comprehensive generalizability requires data on large populations as is often the case in quantitative research, and would therefore provide the best foundation for a broad generalizability. It indicates that the larger sample population is, the more generalizable is the results (Collins & Hussey, 2009). As this master's thesis is a qualitative study mainly based on interviews and documentation in a specific industrial/business segment, the results could not be generalized in other business segments. This research can therefore be generalized to companies in the process industry. However, as the process industry is a global industry with various companies all over the world, the work progress could be different in different regions on the globe, and therefore this study is preferably generalized to regions similar to Scandinavia. The pre-study with open interviews and initial literature study indicated that the process industry is homogeneous, and this study could therefore be generalized to companies/departments working with R&D in the process industries with. However, the correlations are strongest to R&D companies related to bio-refinery, pulp etc.

2.10 Overall quality discussion

A method which has been taken in to consideration is using a quantitative approach in gathering data. Such an approach would include a large scale survey that would be sent out to a wide spectrum of key persons in different companies. The problem with this type of research for the problem formulation of this thesis is that it decreases the probability of finding something crucial as the possibility of attaining in-depth information from key persons is highly minimized. The possibility of having a conversation is very important in this type of study and investigation, therefore the qualitative approach with case study and interviews is most suitable.

As the aim of this report is to achieve a high general quality, this case study has been conducted and reviewed in a number of different ways in order to reach credible conclusions. The methodical approach emphasizes on the following parts; case study, interviews, and literature review. This could be considered as a triangulation method, which enhances the credibility of the results. Each part of the methodology has been conducted in cohesion with a literature study in order to grasp and depict one main part of the problem area at the time. To be noted is that the interview section in the second phase is not related to the interview section of the case study in the third phase. There are several interviews in the third phase in order to support the data triangulation approach, and the interviews in the second phase (which also has been conducted with data triangulation) will support the methodological triangulation approach.

The interviews have been performed with key persons from nine different companies. This sampling allowed a detailed description, covering large aspects from companies in fields at various different levels in the innovation value chain in order to grasp perceptions necessary from different actors, and reach credible conclusions. There is a possibility to further extend the interviews and include more interviewees and other targets. However, even though the interviews with sixteen different people lead to new discoveries, due to limited time-frame and especially the similarity of answers among several interviewees indicated that additional sampling will arguably not provide any further breakthrough in the support of the case study. The quality of this report will not differ even though the generalizability is slightly more limited from a scientific point of view. The different methodological approaches of this report enables the quality to be kept high and will also provide several options directly available to draw conclusions from if one method should provide insignificant results/answers. Such an approach will guarantee that the case study depicts and provides reasonable answers for the main objectives.

3 Theoretical background

A theoretical background will be presented in this chapter in order to form an underpinning for the specific theories used later on, and the research overall.

3.1 Research and Development

The world has seen an astonishing growth in the size and complexity of organizations since the beginning of the industrial revolution. Companies, businesses and corporations have evolved from small shops into global million and billion dollar industries of today. R&D processes has in the same manner as the network model of innovation (see chapter 3.6), evolved from a technology-centered model to a more interaction-focused view (Hillier & Lieberman, 2001; Nobelius, 2003). This revolutionary change is essentially due to the steadily increase in the division of labor and segmentation of management responsibilities in these organizations. As the result has been phenomenal and created great advantages, it has also generated new organizational problems that still exist today (Hillier and Lieberman, 2001). Professor Likierman (2010) indicates in the paper 'beating silos into shape' that as soon there are decentralization in an organization, a temptation based on financial incentives will rise from those running one part of the organization to promote their own pathway. The problem occurs in many organizations as different departments of the organizations create their own goals and values, resulting in a tendency in losing sight of what is best for the overall organization (Hillier and Lieberman, 2001).

In order to stay competitive, organization has to align different departments and sectors in the organization (Likierman, 2010). As many companies identifies Research and development (R&D) as high risk with high uncertainty, R&D along with innovative visions can be one way for an organization to realize a competitive advantage. Companies could furthermore achieve a very sharp competitive edge if they succeed in commercializing new technology in an accurate method, thus attaining great market share and dominant designs (Nobelius, 2003). One major task of innovation strategy is building an organization that are responsive to change, thus making R&D functions and management within an organization a central feature (Tidd, Bessant & Pavitt, 2005). As the world has seen great growth in different fields of knowledge and technology much thanks to research and development and innovative progress, there has been major environmental consequences that has to be dealt with, thus the evolvement of eco-innovation and research and development in environmental sustainability (Kobayashi et al., 2011) that this master thesis will regard in following chapter in order for R&D companies and departments to achieve a successful commercialization.

3.2 Eco-Innovation: Innovating for sustainability

The conventional understanding of innovation according to the Oslo manual is generally distinguished between process, product and organizational innovation (Kemp et al., 2007). This general definition is neutral concerning the context of the innovation process. The categories could be useful for research on sustainable development but are not sufficient because the definitions does not provide for an explicitly distinguished notion of environmental and non-environmental innovations. Eventually, as there are growing concerns about the direction and content of the innovation process, putting explicit emphasis on innovation towards sustainable development is therefore motivated, hence the realization of the term Eco-Innovation. Consequently, the general definition of Eco-Innovation is viewed to be the process in developing new ideas, behavior, products and processes, and apply or introduce them in order to contribute for a reduction in environmental burdens (Rennings, 2000).

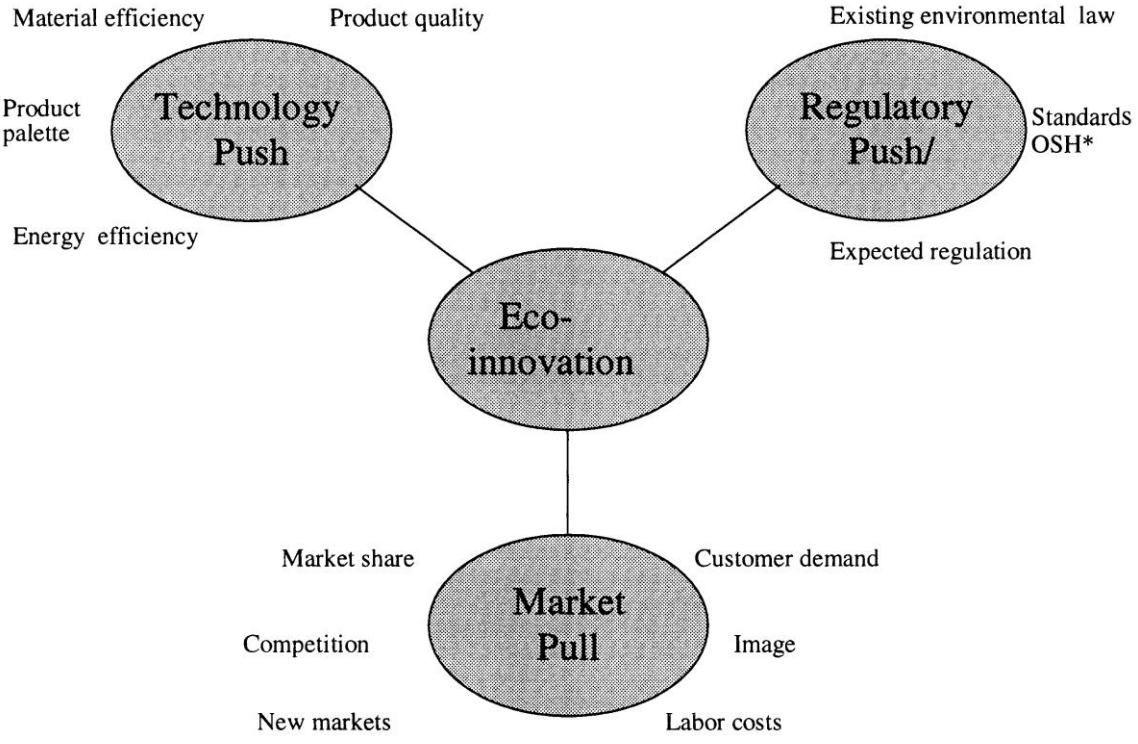

Figure 3. The determinants of Eco-Innoation (Rennings, 2000)

Figure 3 above illustrates the determinants of Eco-innovation that consists of a market pull, technology push and also a regulatory push. Factors of technology push and market pull are though alone not strong enough. Eco-innovation need specific regulatory support, and therefore the regulatory push with environmental policies

has strong impact on eco-innovations in contrast to technologies in different fields (Rennings, 2000).

3.3 Alliances & networking

Strategic alliances have experienced rapid growth since the 1980s, especially in undertaking development activities (Narula & Hagedoorn, 1998), and are often viewed to be the competitive weapon of the century (Trott, 2005). Much due to the globalization and contemporary business environment that forces companies to create alliances, thus establishing a powerful tool for meeting customer demand and gaining better market position (Stefanovic & Dukic, 2011). The term 'strategic alliance' can mean different things, but is commonly regarded to be an agreement between firms that obligate and commit for resources, mutual need and risk sharing in order to achieve certain set of objectives, thus providing access to resources that would be difficult for a single actor to obtain. Strategic alliances can be formed with a variety of actors, ranging from customers and suppliers to divisions in governments, universities and even competitors (Steinhilber, 2008; Trott, 2005). By forming a strategic alliance for external technology commercialization, companies can enhance their competitiveness or gain a competitive edge. Strategic alliance could also provide eligible entry into new markets and improve companies' ability to create new products and technologies that are necessary in today's markets (Trott, 2005). The corporation in strategic alliance is mutually valuable and intended explicitly to support and build up the competitive advantages of partners. However, despite the undisputed advantages, failure rates up to 50% are not uncommon in these kinds of partnerships due to a number of reasons. Strategic alliance has its advantages and disadvantages as any process, and takes a lot of effort from the partners in order to achieve the set goals (Estañol, Meloso & Seldeslachts, 2012). For successful partner selection in alliances, Holmberg & Cumming (2009) has illustrated a systematic selection process, se figure 4 below.

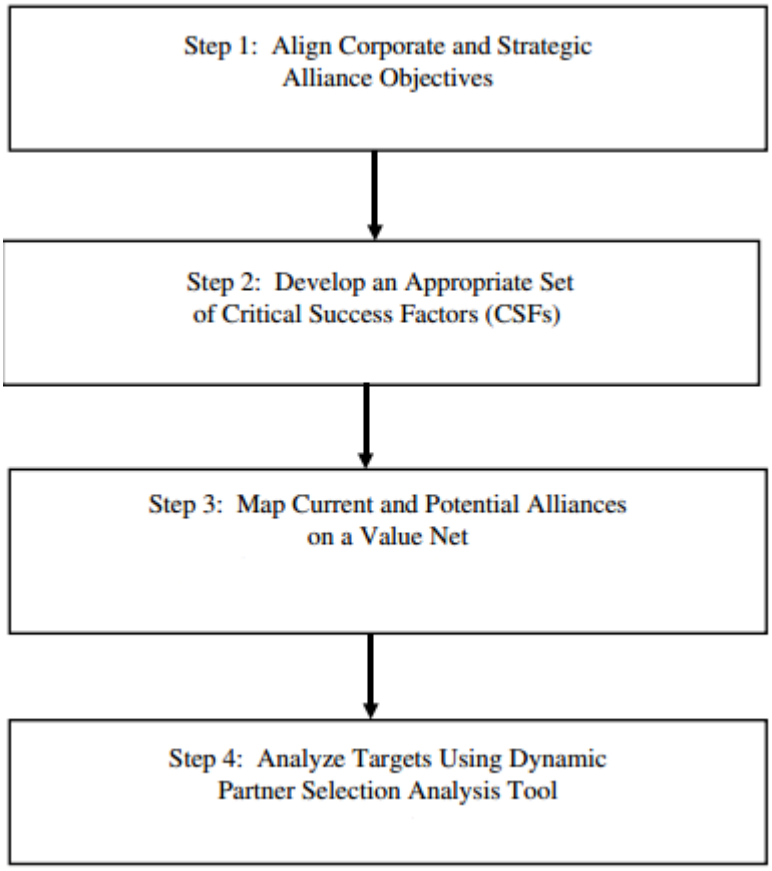

Figure 4. Alliance Partner Selection Process

According to Holmberg & Cumming (2009), a partner selection process and related analytical tool will provide a foundation for companies in which they can evaluate alliances systematically, dynamically, strategically, and therefore increase success rate of alliances.

3.4 Innovation alliances in R&D intensive companies

One major factors that hinders many companies in achieving technical objectives, and thereby the strategic objectives is insufficient resources. Companies that are very intensive in research and development (R&D) need this critical mass of capital in order to build and sustain necessary technical expertise and equipment (Trott, 2005). For such large and small high-technology companies, strategic alliances offer the possibility to expand into new markets by sharing skills and resources. The benefits for both parties mutually since the alliance could allow the large firms to access external expertise they aspire, while the smaller could utilize the larger external resources from the partner and provide future potentials with new innovative products (Slowinski et al., 1996). Slowinski et al. (1996) argues that the formation of a strategic alliance is a three-step process that begins with the selection of right partner, negotiating with the potential partner's based on the needs, and

management towards collaboration. The management towards collaboration incorporates certain activities such as joint goal-setting. The realization and success of such alliances is determined by the existence of mutual need and ability to cooperate despite differences between the partners (Slowinski et al., 1996).

R&D and the innovativeness that follows play a vital role in accomplishing business efficiency. According to Stefanovic and Dukic (2011), every strategic alliance with the goal of becoming the market leader in a certain field, have to invest in innovation and formalization of strategic innovation system. The successful implementation of a strategic alliance that realizes the importance of formulation and implementation of innovation strategies will enable sustainable competitive advantage for strategic alliances (Stefanovic & Dukic, 2011).

3.5 Forms of strategic alliances

Most innovations require some form of cooperation and alliances with partners in order to develop and/or commercialize the innovation (Tidd & Bessant, 2009). As the failure rate of joint ventures and alliances are high (Estañol, Meloso & Seldeslachts, 2012; Tidd & Bessant, 2009), it is important to address factors that affect the success of an alliance. Those factors can in turn be dependent on type of alliances. Strategic alliances can be divided into intra-industry and inter-industry alliances. Intra-industry alliance is for example were manufacturers from the same industry form an alliance to develop a product, whereby inter-industry is an alliance with firms from a variety of industries. Further on, there are eight generic types of strategic alliances; Licensing; supplier relations; outsourcing; joint venture; collaboration; R&D consortia; industry clusters; and innovation networks (Trott, 2005).

Licensing refers to an arrangement in offering a firm's know-how or other intangible assets to a foreign company for a fee, royalty, and/or other types of payment. The licensor that owns a trademark or other intellectual property permit a legal licensee to another company/party to use these trademarks and intellectual property, and thus a relatively well-established method of acquiring technology/information that otherwise would not be attained (Trott, 2005). Licensing technology could also provide a low-risk way to capitalize intellectual property assets due to the high cost of manufacturing and relatively small investment of licensing. However, before a company contemplates on licensing its technology, it's important to consider other alternatives in taking advantage of own technology, such as with joint ventures and strategic alliances (Fernandez & Neuenschwander, n.d). Further on, companies that wants to invest in and utilize a trademark or other intellectual property from a licensor, there could be a potential problem in neglecting own internal technology development (Trott, 2005).

Supplier relationship is a process that defines how a firm interacts with its supplier, including factors on how the relationship with suppliers are developed and maintained (Lambert & Schwieterman, 2012). As mean to stay competitive in a global and demanding market, product development process has since a few decades ago encouraged a closer and more cooperative relationship in product development (Lakemond, Berggren & Weele, 2006). It has evolved to a critical business process in many industries were the closer relationship with key supplier has the ability to provide necessary expertise in order to develop innovative new products and commercialize them successfully (Lambert & Schwieterman, 2012). The benefits of supplier relations is usually cost-related, such as lower production costs in order to provide components for a company that fits more easily to their set of products and reduced R&D expenses based on supplier information on opinions of- and how the product is used by customers. This informational flow between supplier/buyer could improve material flow, reduce inventory expenses and administration costs. The relationship could take a step further and evolve into a cooperation were experience, expertise, knowledge, and development of new products are shared (Trott, 2005). Studies has shown that high level of integration and relationships with supplier indeed results in improved performance (Rosenzweig et al., 2003; Frohlich & Westbrook, 2001).

A Joint venture is an arrangement between two or more companies/business units with an ambition in pursuing a single project by combining their resources and assets, were the risks and possible benefits of the venture is shared between the companies (Trott, 2005; Beamish and Lupton, 2009). The joint venture is a legal entity and supports firms in gaining access to new markets, capabilities, knowledge and other resources (Beamish and Lupton, 2009). There are though potential downsides in entering a joint venture, such as cultural differences that can lead to misunderstandings, misalignment or divergence in strategies, incongruent goals, lack of trust etc. However, if managed correctly, joint venture can be an appropriate investment with potential (Byrne & Popoff, 2006).

Collaboration (Non-joint venture) is a type of strategic alliance between two entities with the goal of providing mutual benefits for each entity (Trott, 2005). The collaboration could be between businesses, non-profitable, or between health and educational institutes (Gajda, 2004). Departments in universities could work with local firms in projects of common interest, for example a local firm may use a special material in manufacturing that are in interest for a department in the university (Trott, 2005). As several other types of strategic alliances, collaboration has increased due to the very high demands placed on single organizations in an increasingly competitive environment, especially in the technology sector (More & McGrath, 2001).

R&D consortia are a form of collaborative effort where a number of firms cooperate to undertake what is often large-scale research and development activity (Trott, 2005). The motives of joining an R&D consortium is that the multiple firm efforts allows cost and risk sharing were firms also can pool expertise, equipment, perform pre-competitive research and set standards jointly. This type of alliance is at times joined by governmental owned institutions, national labs and universities. (Ring, Doz & Olk, 2005).

Industry clusters are geographically defined regional clusters of companies that function as a strategic entity in a particular field (Tallman et al., 2004). The clusters incorporate a range of related industries and other entities that are important for competition, such as specialized suppliers and service providers. The clusters also often extends to customers, manufacturers of complementary products, and to companies in industries related by skills, technologies, or common inputs, and include governmental and other institutions that provide specific expertise (Porter, 1998).

Innovation networks is a type of a strategic alliance that has little consensus in the literature about what it exactly is about or what it exist, however there are some consent that a network is more than a supplier and customer relationship (Trott, 2005). Networks are commonly linked organizations (firms, universities, government agencies) with ambition in creating, acquiring, and integrating diverse knowledge in order to create technologies to the market. Innovation networks are thereby organized around constant learning according to. According to Ahrweiler & Keane (2013), innovation network is characterized by the interplay of people, ideas and organizations to create products, processes and organizational structure that are technologically and commercially feasible.

3.6 Rothwell's Five Generations of Innovation Models

The concept of Rothwell's five generations of innovation models illustrates the development of innovation processes from simple and linear models in the first generations to more complex models in the later generations. The first and second generation can be illustrated as the basic technology push - market pull processes. In the third generation, the interaction between different elements such as R&D, marketing and manufacturing is recognized and the importance of "feedback loops" is highlighted. As the previous models are more linear and lack functional integration, the fourth generation model was developed in order to account for not only integration of company functions, but interaction with the entire supply chain along with emphasis on partnerships and alliances. However, as the fourth generation does not explain the whole innovation process, the fifth generation model evolved as an attempt to clarify the complexity of the whole innovation process.

The fifth generation demonstrates systems integration and networking which enable flexibility and continuous innovations with influences of external environment. It highlights that innovation transpires within a networks of internal and external stakeholders, hence the alternative name 'network model' which denotes the important link between all role-players in order to aspire for innovation (Tidd & Bessant, 2009). The network model of innovation is essentially a model that is very contemporary (Tidd & Bessant, 2009), which eventually indicates the need of further investigating certain aspects of it in the following subchapter.

3.6.1 The network model of innovation

The focus of the network model of innovation revolves around certain attributes and strategies such as; fast and more efficient product development, higher quality focus, higher emphasis on corporate flexibility and responsiveness, accessing external know-how, higher customer focus, have strategic integration with primary supplies and strategies for horizontal technological collaboration etc., (Rothwell, 1994). These strategies concerns centrally integrated and parallel development processes with vertical and horizontal linkages and stable corporate structure. The horizontal linkages regards collaboration with other R&D companies in a precompetitive phase with R&D-based strategic alliances (Rothwell, 1994).

Figure 5 below illustrates the different segment in the innovation process of the network model, rich and diverse linkages in the network and accumulating knowledge from the segments over time. The four different segments represents divisions of finance, marketing and sales, research and development, and engineering and manufacturing (Trott, 2005). The core emphasis of this thesis will be on the marketing and sales segment. The marketing and sales segment regards external factors such as competitors, supplier, partnership, distributors, customers and strategic alliances. This thesis will therefore investigate and analyze common denominators of those factors in order to depict and provide comprehensive conclusions for R&D companies with lagging factors in marketing and sales.

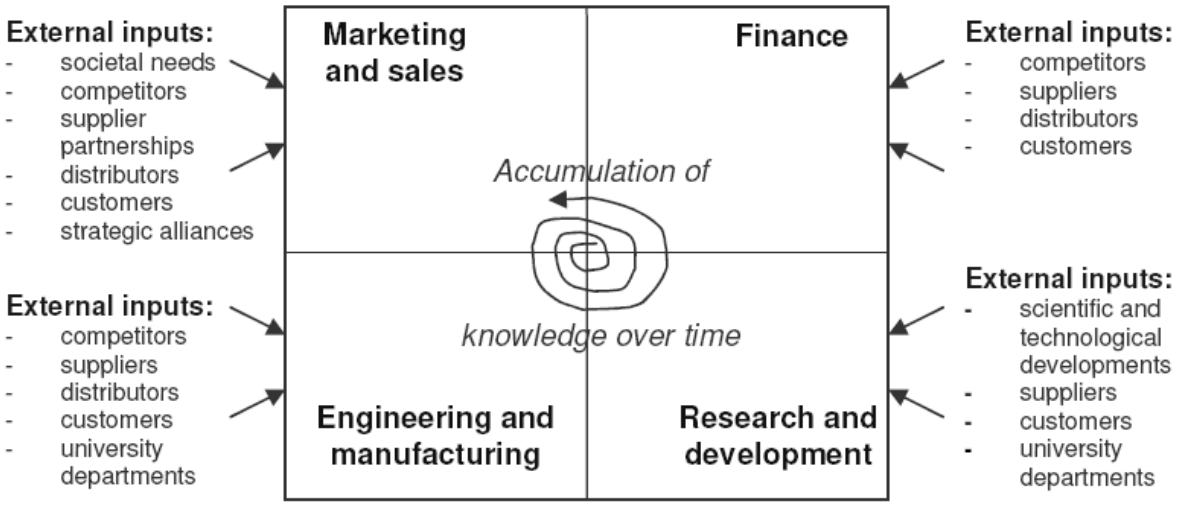

Figure 5. The fifth generation model of innovation (Trott, 2005)

4 Theoretical framework

This chapter will present previous research on topics related to external technology exploitation, pre-commercialization, road-mapping etc., and will serve as the theoretical framework for this thesis.

4.1 The five steps of external technology commercialization

The five step process model of external technology commercialization is a synthesized model made by Lichtenthaler (2007). The process explicitly includes five steps:

1. Planning
2. Intelligence
3. Negotiation
4. Realization
5. Control

Planning

The planning phase constitutes of the interface between corporate planning processes and the planning of external technology exploitation. It consists of strategic technology planning, target setting, resource allocation and technology customer pre selection. (Grindley & Teece, 1997; Lichtenthaler, 2005; Rivette & Kline, 2000) identifies that the planning stage is a critical activity in order to secure strategic benefits such as setting industry standards, realizing learning effects, gaining access to external knowledge, profiting from a firm's intellectual property

and guaranteeing freedom to operate. Commercializing a technology revolves around converting a technology to profits through converting mechanisms such as out-licensing, joint venture and strategic alliances and a set of questions need to be answered in the commercial decision process. The commercial decision process is illustrated by Sullivan and Fox (1996), see figure 6 below.

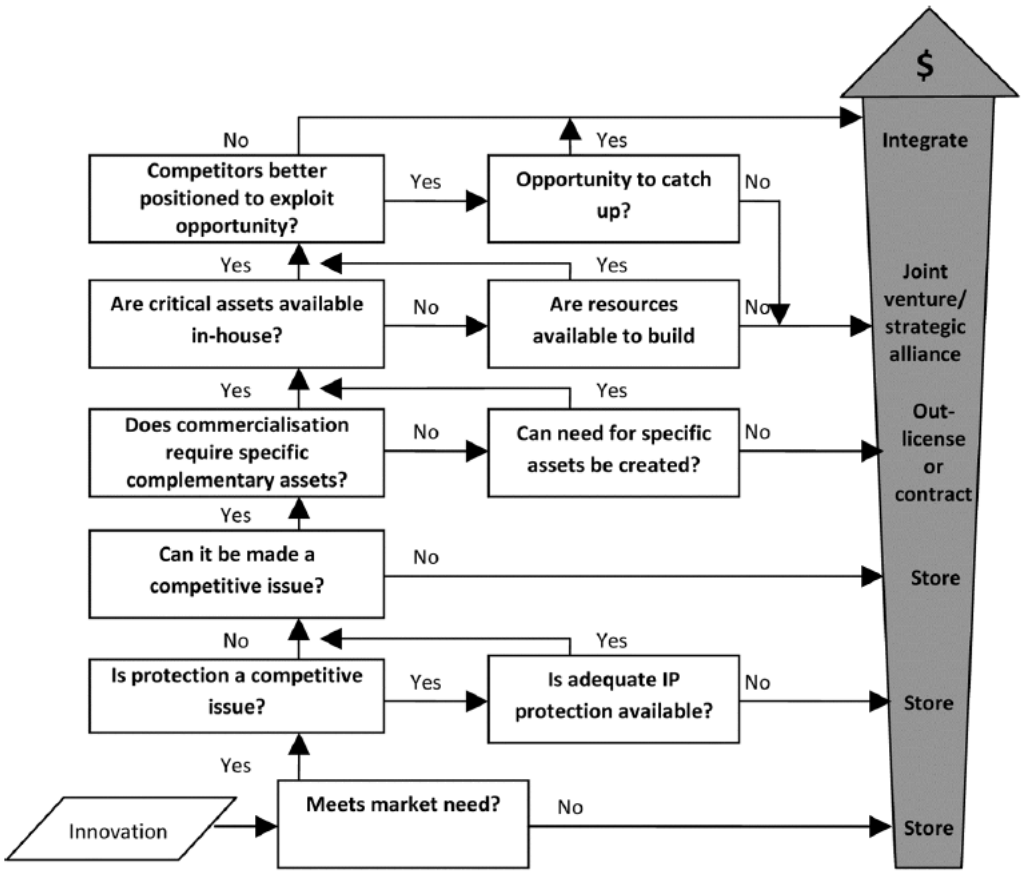

Figure 6. The commercialization decision process (Sullivan & Fox, 1996)

Since the planning stage has coordination role, integrated instruments such as roadmaps could be used and be embedded into strategic technology planning processes (Kutvonen et al., 2010). A company which is exploring the potential consequences of an outward technology transaction must pay extra attention to the risk of losing core competences and thereby strengthening competitors. Teece (1998) states that some companies which is not attentive to planning processes may have difficulties to reach the right technology customers and align internal and external technology exploitation.

Intelligence

Lichtenthaler (2003) defines the intelligence phase as the process of scanning a firm's technology environment for commercialization opportunities and monitoring the markets for technology. It further includes the identification of information needs, evaluation of information and communication channels. (Kutvonen et al., 2010) further proposes that after the suitable technology customers are pre-selected communication channels are set up in order to offering and promoting the company's technologies.

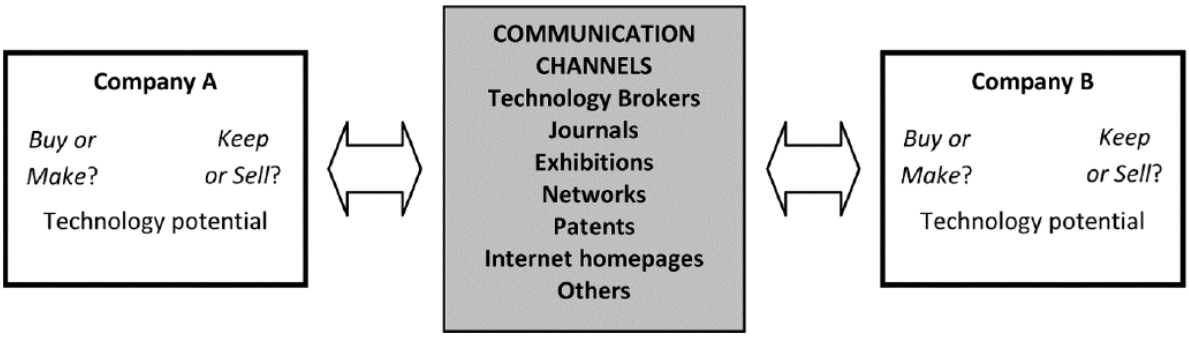

Figure 7. Communication channels (Escher, 2005)

Finding appropriate communication channels could be done both actively by identifying search channels, and passively by identifying promotion channels. Kutvonen et al. (2010) points out that internet based technology brokers and webpages recently has become a complement to traditional communication channels. As a final step in the intelligence phase identification and analysis of the firm's competitors and customers are performed.

Negotiation

The negotiation phase involves the contact point with technology customers which the company has identified as potential customers in the earlier planning phase. During this phase, pre-commercialization activities begin to realize its value. Since an exchange of highly confidential information may occur between parties a certain level of mutual thrust and understanding must be met in order to initiate the negotiation phase (Kutvonen et al., 2010). The intelligence phase is considered to be of even greater importance when there is a bi-directional knowledge transfer or the aim is to set an industry standard.

Realization

The realization phase refers to the operational process of execution of design and implementation tasks (Kutvonen et al., 2010). It further involves the parties' ability to transfer technology on an operational level. Mapping the processes should aim to

decrease the potential risk of interface and coordination problems. A modularized technology may according to Kutvonen et al. (2010) facilitate the transfer between the parties. Learning opportunities could occur at both parties' during a technology transfer. However, a firm's absorptive capacity and the support of the knowledge provider are critical in order to reap the benefits of a knowledge transfer. Different incentives to technology transfer may exists and Kutvonen et al. (2010) gives bi-directional transfers, licensing agreements and performance related forms of monetary compensations as examples. Differences in technological know-how and information asymmetry among the companies may lead to disruptions in technology transfers. Redirecting resources from internal innovation processes to transfer activities could lead to a decrease in the efficiency of the realization process (Escher, 2003; Lichtenthaler, 2005).

Control

The control phase comprises the identification of information needs, information generation, information evaluation, and information communication. The control phase are closely connected to the planning- and intelligence phase. The aim of this stage is to secure learning effects from external commercialization of technology and to be able to redirect and terminate processes. Relevance of the generated information must be determined in order to capture organizational learning. Determine success factors through analysis and documentation of technology transfers are also vital in the control process. Kutvonen et al. (2010) further mentions that the combination of the accumulated experience and control mechanisms will eventually lead to a dynamic capability of externally leveraging technology assets.

4.2 Technology commercialization roadmaps

Last decade, firms have increasingly acquired technologies from external sources and exploiting technologies outside their own company (Lichtenthaler, 2008). According to (Lichtenthaler, 2008) technology transactions have generally been neglected as a strategic trading activity among firms'. Even though firms can identify major benefits with external technology commercialization through collaboration with other actors, strategic technology planning processes must be put in place to overcome challenges and to fully reap the potential benefits. In a study by (Lichtenthaler, 2008), technology roadmaps is analyzed as an instrument which companies could use in order to facilitate the strategic planning phase in an open innovation context where technologies and knowledge are exploited externally.

Strategic technology planning refers to a process which puts emphasis on the importance of the interface and alignment between firm's general corporate

planning processes and the planning of external technology exploitation. It also influences the company's overall innovation strategy. Lichtenthaler (2008) found that most companies pursue an ad hoc approach to external technology commercialization which often leads to difficulties in the tasks prior to the technology transfer. Companies that have adopted a strategic approach to technology planning pays extensive attention to the coordination between individual technology transactions and the firm's internal technology exploitation strategies of their products (Lichtenthaler, 2008). A strategic planning process takes both technology-oriented and product-oriented aspects into consideration.

Several benefits with external technology exploitation are identified by Lichtenthaler (2008). One of them is to establish its own technology as an industry standard by multiple out-licensing agreements. Other potential benefits from external technology exploitation are detection of commercialization opportunities and finding new markets. As example the company's technologies may offer a solution outside the industry were they normally operate and other companies may find a new application for the technology which the company has not thought of. Proper strategic planning processes where agreements with different partners are coordinated may also facilitate the establishment of industry standard setting.

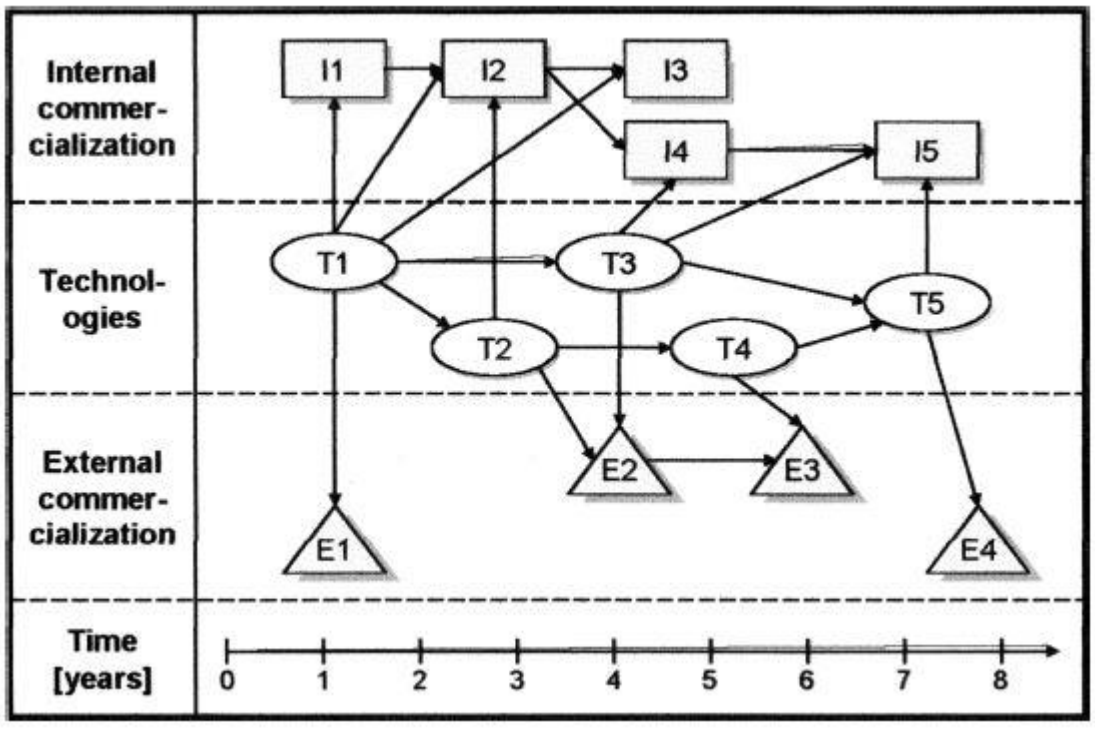

Figure 8. Technology roadmap (Lichtenthaler, 2008)

Figure 8 is an example of a technology commercialization roadmap, and provides an illustration of a company's relevant technologies (T) and their internal exploitation

in terms of product applications (I1-I5). (E1-E4) shows external commercialization projects. The technology roadmap shows the connection between internal exploitation, the technologies and external commercialization project as well as the connection between the three different levels.

The technology road map is generally put together by a group of technology and marketing experts and should provide a holistic view of the current and future technologies both internally and externally and help the companies in the decision making in the planning processes. Strategic planning helps the company to decide whether technologies are preferable commercialized by integration into product markets, by selling intermediate output or by out licensing (Lichtenthaler, 2008). It may also facilitate the coordination of activities and resources especially in turbulent environments. Lichtenthaler (2008) gives an example of an integrated planning process where a company's licensing function is closely tied to the product marketing unit. Some technology assets and the technology portfolio may not be possible to exploit internally and can be identified by the licensing function as an opportunity to reap major financial profits through external actors.

4.3 Customized roadmaps for different purposes

Even though academics and practitioners has paid increasingly attention into the concept of technology roadmaps the benefits of integrating it into the company's business strategies may be harmed due to perceived difficulties to customizing the roadmaps to the specific needs or circumstances surrounding the company (Lee & Park, 2004). Firm-specific managerial needs and environmental conditions have been identified as main drivers to increase the flexibility in roadmaps. The diffusion process of technology roadmaps have also been relatively slow. Due to these difficulties Lee & Park (2004) developed guidance for customizing roadmaps. The term "Technology Roadmaps" is according to Lee & Park (2004) somehow misleading since technology is often considered to be just one aspect combined with other aspects such as business, strategic and innovation.

Managerial usages, object of mapping, and two attributes of roadmap

Managerial usages	Forecasting	Forecast of future technology trend in general
	Planning	
	Project	Plan for future R&D based on internal and external analysis
	Product	Plan for future product based on internal and external analysis
	Administration	Management of current R&D portfolio and product portfolio
Objective of mapping	Product	Support of strategic decision-making related to product
	Technology	Support of strategic decision-making related to technology
Additional attributes	Information source	Domain of information-collection or data-analysis
	Time frame	Scope of time covered in the roadmap as horizon of mapping

Figure 9. Dimensions and usage of roadmaps (Lee & Park, 2004)

As illustrated by figure 9, forecasting, planning and administration are the dominant managerial purposes for using roadmaps. First of all Lee and Park (2004) put emphasis on the importance of forecasting in order effectively enable decision making regarding technologies.

Secondly, the planning dimension is focused to redirect the company's short term perspective to a perspective which is based on a long term horizon. Planning activities includes an identification of current available technologies and experts' opinions from different business areas to create a foundation for future R&D and product planning (Lee & Park, 2004).

Lee & Park (2004) further conclude that roadmapping can be an effective administration tool which facilitates communication efforts between different levels of a company which is specialized on different areas. Easy access to information related to roadmaps also increases the information sharing within the company which could have the impact to reduce product and technology uncertainties.

4.4 Roadmaps as a tool for selecting and forecasting technology trajectories

Rinne (2004) argues that technology roadmaps have the potential to become the infrastructure of innovation and a main driver of innovation. Since technology and markets coevolve roadmaps could provide a convergence between innovation and forecasting. Integration of roadmaps widen the context of innovation and bringing elements from different roadmaps together could lead to unexpected synergy effects between technologies that seemed to be unrelated.

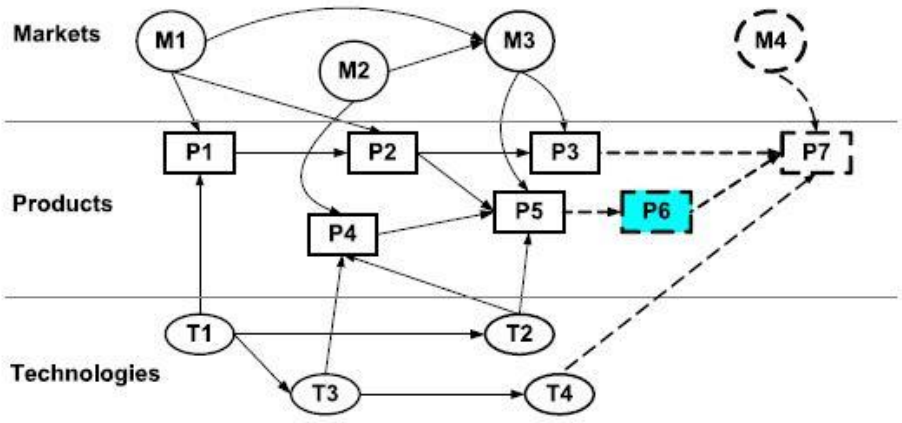

Figure 10. Virtual Innovation Rinne (2004)

Figure 10 illustrates what Rinne (2004) refers to as "virtual innovation". It's an envision within the technology roadmap which suggest technologies, products and markets which may be next in line. Instead of the traditional innovation processes which include concept development, prototyping and manufacturing virtual innovation seeks to innovate without creating tangible prototypes and products (Rinne, 2004).

Forecasts and projections for future technology trajectories are also dependent on how efficient ideas are captured and kept alive as projects proceeds. Rinne (2004) concludes that technologies which might be considered to be of low individual value in the roadmap of a company could have be very valuable when new innovations are created which is a result of the rearranging of existing components from several companies technologies. Integrating companies' roadmaps may facilitate the use of valuable ideas which is outside the expertise of the reflected technology and gaining a broader context for innovation could be particularly useful for searching for new disruptive technologies (Rinne, 2004).

A possible disadvantage publishing technology roadmaps which include future technology trajectories may be to reveal a company's intentions. However, (Rinne, 2004) argues that the loss in competitive advantage due to these revelations will likely be far less than the potential gains derived from the interactive access to the markets and customers reaction.

4.5 External technology commercialization in projects

In a case study based on 25 technology oriented companies Lichtenthaler (2008) investigated objectives and managerial related challenges in external technology commercialization projects. According to (Lichtenthaler, 2008) external technology commercialization (ETC) has been focusing on the monetary dimension and neglecting the strategic opportunities. Another aspect which has been foreseen is the legal requirements which may force some companies to externally commercialize their products. The monetary dimension is defined as the possibility to generate revenues externally which could not have been realized by internal technology commercialization activities.

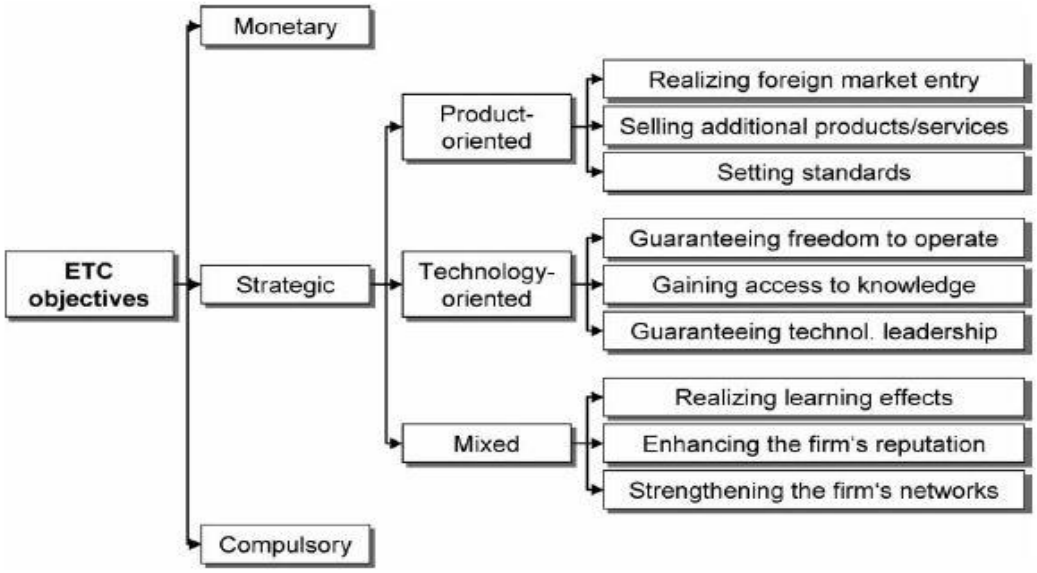

Figure 11. Illustration of strategic ETC objectives (Lichtenthaler, 2008)

Strategic ETC objectives is divided into three subcategories with focus on product oriented, technology oriented and mixed aspects. Product oriented objectives are primary aimed to support the company´s internal technology commercialization activities and could as an example include licensing agreements to get access to new markets to increase product sales. Technology oriented objectives revolves around the process of strengthening the firm's technological position. Rather than exploiting certain products, the key focus is on future technology potential. The third category of strategic objectives is a mix between the technology and product level and the main reason to combine these objectives is to realize learning effects (Lichtenthaler, 2008). (Lichtenthaler, 2008) further divide external commercialization projects based on the importance of monetary and strategic objectives in the specific project context and addresses the managerial challenges which could emerge, see figure 12 below.

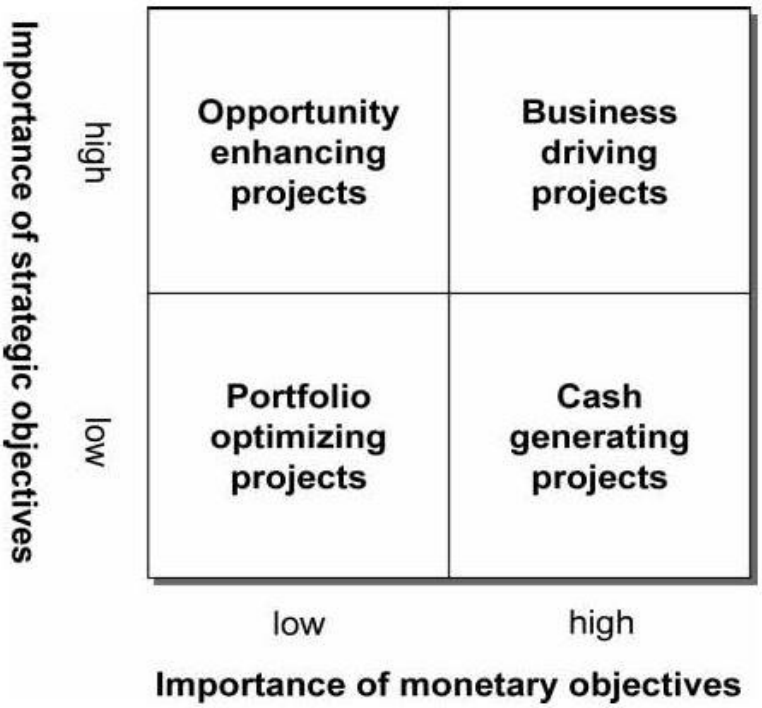

Figure 12. Classification of projects (Lichtenthaler, 2008)

5 The case study

This chapter will introduce a short summary of the project investigated during this research as a part of research phase 3.

The project of the case study is a European research project coordinated by Innventia and started in 2010. The Purpose was to demonstrate a new efficient technique for producing multi-ply paper and paperboard with different properties for each layer. With the technology, savings are made in both raw material and energy consumption. The project ended in May 2013. Thanks to the four-year work, there are now a toolbox of techniques to compose the basis of industrial development beyond the project's primary goals with reduced carbon emissions and improved resource efficiency in terms of energy and fiber. The project was a large-scale collaborative project with 11 partners from five countries in the EU's Seventh Framework Programme, with a total budget of EUR 11 million, of which EUR 7 million was funded by the European Commission and coordinated by Innventia.

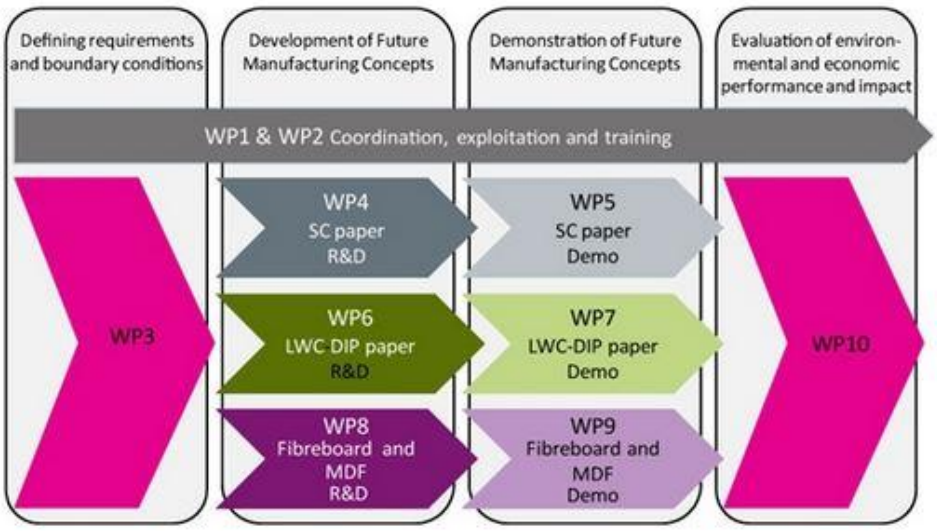

Figure 13. Illustrations of Phases of the case project

The case project consisted of 10 Work Packages (WP). The work packages were a description of the required activities and the involved participants. The work packages were also divided on a technology and process basis since the aim was to develop a manufacturing concept heavily dependent on the specific technology. As the illustrations show, coordination, exploitation and training was activities that had to be performed throughout the whole project.

WP3 consisted of technology screening activities, idea evaluation and development of simulation processes which could predict the impact on product properties and process efficiency. WP3 created the foundation for the following WP's. WP4, WP6 and WP8 were R&D activities which were performed in parallel. The R&D activities lead to the setup of different demonstration and pilot tests (WP5, WP7 and WP9) and the results from these tests were then evaluated.

Figure 14. Evaluation criteria's of the case project

WP10 was an integration of all the previous WP's and consisted of evaluation activities based on the criteria's in figure 14. Evaluation criteria's were closely linked to the goals that were set in the early planning phase of the project.

6 Empirical results and analysis

In this chapter, the empirical findings will be presented and analyzed in reference to the theoretical framework in chapter 4. The empirical findings are mainly related to the interviews and the case study investigated in this research, and related to the thorough literature study. This chapter will be divided into 7 part; Project initiation, Target setting & Purpose, strategic planning development, technology screening, partner selection and planning tools. There are no strict bounds on each part, and some results could cover several parts. Each subchapter will jointly provide an analysis of the findings of the interviews in research phase 2, case study in research phase 3, and the theoretical framework. The next chapter (chapter 7) will present the conclusion on the major problems and challenges identified in this research, as well as success factors.

6.1 Project initiation

The basic idea and concept behind the project in the case study had been generated a couple of times decades before the project actually started. Even though the idea came up earlier, the lack of knowledge and technologies which could fulfill that idea made it impossible to proceed. When the understanding of the required process increased and technologies and knowledge developed, it was easier to actually start the planning process. A possible explanation that the project could be initiated is that the company finally understood the potential of their knowledge assets and could be able to find an application for it. This is also referred to as a general problem according to (Kutvonen, 2011), which points out that it is common among companies to be unable to see the potential when the technology or knowledge could be used in other than the company's core business or industry. The case study also shows the importance to thoroughly document ideas which are currently not feasible in order to be able to pick them up when circumstances or market environments change. There was no explicitly formulated approach used to document unused ideas, which might be a considerable risk that ideas which are closely tied to specific employees are lost when the person leave the company. This could also be related to tacit and explicit knowledge during new product and technology development (Goffin et al., 2010). Much of the learning in projects of new product development is tacit in nature according to (Goffin et al., 2010), and could similarly be related to ideas (Nonaka, 1994). Those ideas that are based on un-utilized tacit knowledge are therefore lost.

Consequently, managers could face a challenge in trying to stipulate project-to-project learnings, and exploiting new ideas (Goffin et al., 2010).

The senior research manager from the case study explained that inspiration for the project also came from project in other industries. The car manufacture BMW's project "efficient dynamics" was one of those inventions in which the fuel consumption was said to decrease with a significant amount by finding synergies from 32 small technology inventions. Each invention made only a small impact but the combined effect was said to be extensive in terms of fuel savings. Such inspiration is very useful indeed, but could be 'extended' by attaining knowledge, expertise and ideas internally within the firm also. During this research, we weren't able to find such an approach, even among the interviewees. However, there are very R&D intensive companies that have initiated a programme to address such an issue. Airbus (even though outside the process industry) has developed a knowledge transfer programme, the Expertise Transfer (ExTra). The ExTra programme approach supports the identification and transfer of valuable knowledge and ideas among workers who are currently active and experts in their fields, but much of their expertise and knowledge is held tacitly. The transfer programme also considers knowledge transfer from workers who leave the company of change department. The implementation of ExTra has therefore provided Airbus with very positive results (Weber, 2007). Such an approach might be interesting for further investigation and implementation during a planning phase for a R&D company.

The business developer from the case study demonstrated that it is a challenge during the initiation stage to find the right balance between investigating technology commercialization potential but at the same time not being to path dependence on current available technologies. This is supported by some interviewees in research phase 3, were some mention the potential problem of going too deep into discussions about specific technology issues before an analysis of the actual need from the customer or the problem which should be solved, and some interviewee's objects going in into several non-related project simultaneously (however that depends on the magnitude of the company). If the company believes that the need from the customers or market could be fulfilled by the company the evaluation proceeds to a discussion regarding functionality. Path dependence could in certain cases be critical and is sometimes often related to inextricable inefficiencies as studied by Liebowitz & Margolis (1995). However, on a positive noted, David (2000) states:

> *"A path dependent stochastic process is one whose asymptotic distribution evolves as a consequence (function of) the process's own history. "*

Construing that processes that possess a diversity of distributions that are asymptotic (generally the case in the process industry), have prevailing probability

of transition to new technologies that are functions of the past, such as biological evolution. As the process industry faces a major industrial paradigm shift were technology can no longer be pushed out on the market in the same extent as decades ago, it will in turn have a large impact on other actors such as R&D companies which is heavily dependent on research funding from those companies. A majority of the interviewees in research phase 2 mentions that the move from a technology push strategy to a market pull strategy is a great challenge and must include a change in mind-set among the employees. Employees on all levels within the company must be aware that all projects are in larger degree initiated by a customer or market demand instead of focusing on the company's currents assets. As specified by Likierman (2010), in order to stay competitive, organization has to align different departments and sectors in the organization.

A major task of strategy for new technology is building an organization that are responsive to change, thus making R&D functions and management within an organization a central feature (Tidd, Bessant & Pavitt, 2005). Several companies in the process industry (as well as Innventia) is related to Eco-innovations, which as Rennings (2000) points out is heavily related to technology push, market pull, and in some instances regulatory push. Such a simplified model is far behind contemporary fifth generation of innovation model (Trott, 2005). As the project initiation in the case study was directly a multi-organizational project with several actors working on certain development parts, it indicates that there is progress to more advanced models.

Some behaviors are deeply rooted in the company culture and it may be easy to fall into the same pitfalls again and again by forcing products out to the market. From a planning phase point of view, a change in mind-set puts great pressure to only initiate ideas or projects which could be of potential value for the market. However, results from the case study indicates that it is a managerial challenge to combine market initiated projects with research projects since the uncertainties of the research and development is considerable high. For some of the interviewed companies in phase 2, a transformation from a technology based strategy to a market pull strategy also meant challenges and included tasks they had not much experience in, such as performing market analysis in the planning phase. In some cases, a market analysis had been performed before but not in a structured way. This may force companies to move away from their core business activities which could involve high risks.

6.2 Purpose, goal, vision & target setting

The synergetic effect of single technologies (combined effect of each technology to create a final product/technology) in the project of the case study was in the initial planning phase vaguely formulated, as well as the commercialization opportunities.

Furthermore, the senior research manager of the case study also specified that planning in an early stage often includes vaguely formulated purpose which often aims to only state what probable benefits a certain technology could lead to. Getting from the vaguely formulated purpose to actually start a project is considered to be a major step. As Kutvonen et al. (2010) points out; setting project goals and targets must be included in the planning phase to create a strategic fit between a company's overall strategy, resource allocation and technology partner pre-selection. In contradiction to what Kutvonen et al. (2010) suggests, the mechanism for converting the technology to profit opportunities was not thoroughly investigated from the beginning of the project in the case study. A vague formulated purpose combined with high uncertainties in the project outcome could have been the cause to why no detailed profit estimation was performed in the first planning phase. Furthermore, Linderman et al. (2003) recounts that goals which are clearly specified and measured will result in higher performance than as the stated "do-best goals", and highly related to an organizations quality management. This is in turn affects the purpose. For the cast study however, it was taken for granted in the planning stage that the technologies which lead to a larger degree of process efficiency had a commercial value for the process industry due to cost.

Harvard business school professor John P. Kotter has studied more than 100 companies in their effort to reinvent themselves (i.e. technology push to market pull), and denotes that only a few of those have been successful. The ability or disability to change and evolve has led the John P. Kotter to write an article to denote eight critical success factors, thus signifying the anatomy of organizational change (Kotter, 1995). This could effectively be related to the project of the case study, or projects generally in various industries, thus improve their process. According to Kotter (1995), posting temporary gains drives credibility when it is most needed, on the long road toward implementation. Most people won't go on a long march for change unless they begin to see compelling evidence that their effort has positive results. In successful transformation and projects, leaders actively plan, set for, and achieve some short term gains which people will be able to see and celebrate. This implies that it's not only goal setting with checkpoints, but goal setting with illustrative and expressive checkpoints, which also could be employed by future projects at the studied company. This provides proof to organization members that their efforts are working, and adds to the motivation to keep the effort going. Focus is also put on energy to fine tune the vision and apply lessons learned along the way (Kotter, 1995). Furthermore, creating a vision (realistic or not) indicates the importance for the project to know where it is being asked to go or contribute with. Having a strong, unambiguous statement that frames the future state is the only way for the project to focus on. The vision functions in many different ways; it helps spark motivation, it helps keep all the projects and changes aligned, it provides a filter to evaluate how the organization is doing, and it provides a rationale for the changes

the organization (and in this case, the project) will have to endure (Kotter, 1995). Such approach is according to Kotter (1995) much efficient, and relating it to the in comparison much less expressive goal-setting and vision in the project of the case study, one could argue that the progress would been more effective with a similar approach proposed by Kotter (1995). However, as it could be hard to create an expressive vision for every single technical project, one could align a project vision with the company vision (which is non-existent in this case).

6.3 Strategic planning development & evaluation

Using the systematization developed by Lichtenthaler (2008), the objectives of the project would fall under the technology oriented and mixed categories. No such categorization of the objectives was explicitly formulated which could have hinder the interface between the corporate planning process and the planning processes of the external technology commercialization project. A possible underestimation of the strategic value of categorizing objective was also found among a majority of the interviewees' in research phase 2. In addition to that, few of the interviewees' companies had an explicitly formulated strategy of technology planning. The most common answer to why no strategy is formulated is that the innovation and high technology area is too complex and case dependent to develop a general planning framework.

The case study and the interviewees' in research phase 2 both showed that the companies and institutes are aware that the adaption of their planning processes to a rapidly changing market environment could lead to managerial challenges and collaborative barriers. However, neither the interviewees' in research phase 2 nor the interviewees' of the case study seemed to be aware that certain managerial challenges could be directly linked to the project objectives. As Lichtenthaler (2008) states, aligning overall business strategy with technology exploitation strategies are even more important when companies are running multiple project which individually could have a different set of objectives. Some of the interviewees' in research phase 2 realized the importance to formulate a cohesive strategy or vision of a project which is in line with the overall company strategy and vision of the senior management. For instance, the director of packaging & logistics from research phase 2 mentioned that an area within the company will improve much more if knowledge from different perspectives and actors are brought together. Cross sectional collaboration is much more common today and companies do seldom apply for single research projects in the way they did more than a decade ago. A complex market environment with extensive knowledge and technology transactions increases the value of networking activities, especially in opportunity enhancing projects which is focusing of reaping the benefits from strategic objectives.

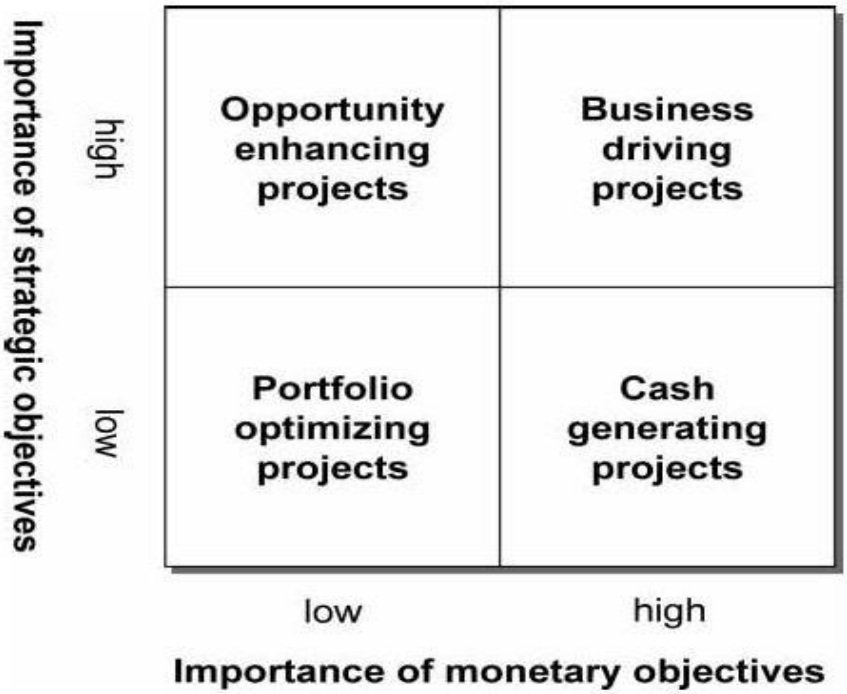

Figure 12. Classification of projects (Lichtenthaler, 2008)

Even though the purpose of the case project was predefined by the European Commission in terms of energy savings, the requirement on financial payback was low and focus was primary on investigating opportunities for future technologies. According to the matrix developed by (Lichtenthaler, 2008), the project would be classified as an "Opportunity enhancing project". The managerial challenges connected to opportunity enhancing projects are primary related to the integration of the company's project portfolio and internal technology exploitation, which according to the business developer from the project of the case study has been utilized in the project by the creation of different work-packages. It could be interpreted as an attempt to increase the integrated managerial approach by finding synergies between current and past projects, and company resources in terms of knowledge and capabilities. The importance to find synergies internally between the company's different business units in order to exploit technology and knowledge externally was also expressed by some of the interviewees' in research phase 2. As an example, the business development & manufacturing innovation manager regularly meet different leaders in their own businesses and cross functional projects in order to inform them and be informed of opportunities and form a cohesive approach to future projects.

According to Kutvonen et al. (2010), resource planning and communication between partners should be closely linked. Resources in the case project were divided based on what activities that the different participants had to perform. Most of the

participants during the project of the case study did however not use all the resources they were given, which is common in projects funded by the European Commission. No resource tools were used, but it was not considered as a problem according to the senior research manager, since the R&D Company was responsible for the overall coordination and knew the partners as they had past cooperation's. Although, the coordination required extensive communication among the participants and every month meetings was held in order to reconcile performed activities.

Seminars and meetings were regularly held in the case project and included all participants. The results from these meetings were documented mostly to avoid future conflicts regarding partners respectively obligations. No strategy for evaluation of the communication channels was put in place and this was also found to be a missing part of a majority of the interviewees' company's in research phase 2. The company of the sales manager in research phase 2 was an exception since they evaluated communication channels based on how efficient that specific channel is to get in touch with decision makers in the value chain. However, the problem with communication channels is according to some interviewees is that they could be overused. The senior associate principal manager mentioned visits to exhibition as an example that could potentially lead to an overload among the employees in terms of information and impressions. During seminars, exhibitions and conferences it is also important to pay attention to confidentiality agreements and not reveal sensible information on what the company is currently working on. As the study by Lichtenthaler (2008) points out, a contextualization of technology exploitation opportunities must always be analyzed and it may difficult if employees get overloaded with opportunities at single occasions.

6.4 Technology Screening & Evaluation

Evaluation and screening methods of an innovation and innovation processes is a critical part, and provide information on whether the innovation should be initiated and adopted (Gerwin, 1981). However, there are an absence of theoretical studies related to the process itself of technology screening and evaluation. As the project of the case study was a research project financed through the European Commission, the involved actors was given large freedom in the way they would execute the project compared to if the project would have been financed through a multinational company in or related to the process industry according to the interviewees from the project of the case study, which was also supported by the majority of the interviewees from research phase 2. The senior research manager from the project in the case study puts great emphasis that projects with the aim of focusing on exploring possible technology trajectories must include a high level of flexibility in terms of changing direction as the project proceeds. This is also supported by the senior associate principal scientist in research phase 2, which sees a major barrier to

develop radical innovations if the scanning for technology exploitation opportunities has a limited timeframe of only 3-5 years. However, some of the companies in research phase 2 are of a different opinion and sees a limited timeframe as a more realistic way of scanning the market as it decreases the uncertainties in the innovation processes. Furthermore, the company of the business development & manufacturing innovation manager of research phase 2 has individuals with backgrounds in different companies and industries which serves as a source of external knowledge and scouting for "what's new out there".

Several interviewees from research phase 2 indicate that technology screening requires interaction contact with other companies, which also was found to be an important component of the project of the case study. Innventia became after all a part of the in case study due to contacts with other companies. The company of the director of packaging & logistics has for example specialists in different areas that are in contact with other companies in order of finding market applications for their knowledge. The market strategy and business development department has also been focusing on creating a structured process to perform market analysis to better understand the environment in which the company is operating. Some interviewees in research phase 2 even mentions the importance to be open minded and look for potential applications and solutions outside the own industry. This is elaborated upon by the senior associate principal scientist, which also as a packaging designer often finds commercial opportunities in the medical, pharmacy, cosmetics, and mobile industry, implying that features and applications used in technologies in those industries may be transferable to the context of packaging. However, both the interviewees from research phase 2 and the case study indicated that in their search for successful new innovations and technologies, no effort were directed in evaluating if the technology actually would be appreciated and favored from a customer perspective (manufacturer, consumer etc.) which should be considered according to Olshavsky & Spreng (1996).

In the project of the case study, instead of only being limited to technologies that were available on the market, the planning process involved an evaluation of alternatives that could be tested and developed through pilot tests. Since the project team had major experience in the specific technology field, they had a good overview of current available technologies and potential partners which could be part of the project. In the company of the process and application manager of research phase 2, the technology scanning process is paying great attention in finding the right balance between the amount and extent of ideas generated from technology scanning and the product and technology portfolio that has to be developed to reach a projects objectives. The technology must ensure high quality but at the same time not take too much resource since that could negatively impact the complementary infrastructure which is needed to shorten the time lead time and time to market. A

technology screening process which is more attentive to market environment also put extra pressure to the importance to find the appropriate balance.

According to the senior research manager from the case study, part of the technology screening also revolves around an analysis of how ready a technology is to be implemented in a process. This is also found in some of the interviewees' companies in research phase 2 were they referred to a term called "technology readiness" which is an estimation of the required efforts in terms of resources and time to get from a development stage to a product and/or process that can be commercialized.

6.5 Partner selection

In the establishment of alliances, be it for external technology exploitation purposes or not, the most critical capability is partner selection which according to Duisters et al. (2008) been identified is numerous studies as a precondition for successful alliances. Consequently, this implies that the partner selection process has to be designed to include criteria's, tool and success factors, and also being applied analytic and systematic in order to increase the success rate of partnership (Duisters et al., 2008). In the project of the case study, potential partners and suppliers were invited to a workshop were they could pitch their available resources, capabilities, technologies and knowledge, however there weren't really any systematic method of partner selection (i.e. partner analysis tools), which could decrease the probability of a successful partnership. Such a systematic approach is also signified by Holmberg & Cummings (2009) in their article *'Building successful strategic alliances: Strategic process and analytical tool for selecting partner industries and firms'*, (See chapter 3.3) where the authors provide a strategic selection process which would benefit project similar to the one in the case study.

During partner selection stage of the planning process, a potential challenge of the project in the case study was that some of the partners was interested to collaborate, but on the premise that the R&D company would buy the chemicals from them instead of competitors. Similar approach was also noted from several interviews in research phase 2. Such approach should be reflected upon with precaution since the success of partnership depends on the level of initial cooperation. Setting demands could drain trust which is very important for successful partnerships. Estanol et al. (2002) concludes in their study that partners need to get it right from the start. This is also related to partners with members that do not directly compete in order to increase the probability of success (Estanol et al., 2002).

The interviewees from research phase 2 indicated that a pre-caution method in the planning process could be to always try to determine the next required step in terms of finding relevant business partners and the regulations that needs to be followed.

As stated by Estañol, Meloso & Seldeslachts (2012), failure rates up to 50% in strategic alliances with collaborative agreements are not uncommon, and companies has to utilize certain measures in order of finding the right partner and increase the probability of successful outcomes. Estañol, Meloso & Seldeslachts (2012) describes that there are many reasons why partnering fails; firms rivalry outside the alliance, poor management and managerial complexity within the alliance, there could also be lack of trust and lack of top management commitment when arranging resources to the alliance etc. The common opinion among the interviewees in research phase 2 were that risks must always be taken into consideration and references from previous customers should preferable be part of the evaluation. An alternative way is according to the director of packaging & logistics to show other companies what they are capable of in terms of knowledge competence or specific technologies, and could lead to other companies being attracted. It should also be easy to find the company if other actors is searching in databases for certain knowledge or technologies.

During the project of the case study, the project planning team decided that instead of just creating a supplier-customer relationship, companies were provided with the opportunity to take a more active role by becoming a project partner. Several interviewees from research phase 2 were of similar opinion, remarking that the form of collaboration also has to be decided early on. The process and application manage of research phase 2 states that most projects related to innovation and new technology involve value chains with different actors and collaborative companies, and it could be a challenge for companies to determine how far in the innovation value chain they have to go. Those problems is probably related to the lack of a systematic model and process on how to proceed with partner selection and plan the whole progress as stated earlier.

The systematization of external commercialization objectives by Lichtenthaler (2008) distinguish between monetary and strategic objectives. The objectives have according to Lichtenthaler (2008) strong impact on certain challenges in external technology commercialization projects. The project of the case study had participants that were initially reluctant to move away from a suppliers-customer relationship, which may have been caused by the fact that they had a short term perspective of the collaboration and thereby focusing on short term profit potential instead of long term strategic benefits such as guaranteeing technology leadership. This could according to Lichtenthaler (2008) lead to less coordination with internal business units and other project related to external technology commercialization. However, according to several interviewees, less coordination requirements means a more flexible organization and the payback time for a project could be shorten. The sales manager of research phase 2 points out that the evaluation of the counterpart's economic situation are important and their company therefore prefer to develop

partnerships with municipalities which has a higher reliability in payments. A clear statement of the ownership of an innovation project is essential according to several of the interviewees'. In high technology businesses it is especially the ownership of the knowledge which could be challenging. It is the opinion of the majority of the interviewees that gaining thrust between actors in collaboration is easier if the companies historically have been collaborating successfully. However, among the newly started companies not widely known, the process of creating thrust between them and different involved actors could be difficult and especially when a company tries to establish a partnership with companies that have been collaborating for several years. Furthermore, to avoid initial managerial challenges, a majority of the interviewees states that a scenario map is written when creating a cluster and figuring out the purpose, mission and the goal of the project. According to the business development manager in research phase 2, formal contracts could create barriers between actors if they are written in a phase when they are not ready for it. However, if a project consist sensible information the companies must pay extra attention to confidentiality agreements. The business development manager further explains that openness among the partners is one of the cornerstones of successful collaboration.

According to Arora et al. (2001), the market for knowledge transactions is much more complex than the markets for most products and services. Kutvonen (2011) also put emphasis on the specific required skills which the parties involved in a knowledge transaction must possess in order to avoid high transaction cost and the resources spent. Contacting potential partners and inviting them to a workshop were they could present and spread their knowledge and technological expertise may facilitate difficulties that could erupt due to these imperfect markets. It is also beneficial from a strategic planning point of view since it facilitates the process of covering the activities which is needed in order to reach the overall project goal. (Kutvonen, 2011) highlights the importance to create a strategic alignment between the participants in order to create a long term collaboration partnership which will last after the end of the project. Since the majority of the project participants in the case study had previous collaboration experience with each other, the institutes and companies have developed a general understanding of the counterparts' strategic incentives to be part of a project. It was however, never expressed explicitly which could hinder the process of establishing partnerships with new participants. Similar understanding was perceived with the sales manager, which states that partners are often familiar with each from before, making it easier to build a partnership due to earlier relationship. However, several interviewees from research phase 2 indicated that it takes a lot of communication to understand different business capabilities and what incentive they may have to collaborate.

Throughout the project, the R&D company had a coordinating role and during the planning phase partners was selected based mostly on collaboration in previous projects and an analysis of the required resources and capabilities during the project. Early on discussions among all partners was held to determine how activities could be distributed. A general acceptance to be willing to create something unique was also considered to be essential in order to be part of the project. Even though the majority of the participants in the projects were involved throughout the whole project, some companies were contacted in a later stage. Part of the planning process within the project of case study was also to include the possibility to increase the number of participants in the later stages of the project. Not being limited to a predefined set of actors could be a success factor since the project could evolve in an unexpected way which requires a different set of capabilities and resources.

The business development & manufacturing innovation manager in research phase 2 mentions for instance that a lot of communication is needed to understand different business capabilities and other partner's incentives to collaborate. The director of packaging & logistics mentions that coordination requirements increases when the company increases the number of collaboration, which makes the process complex and could prove to be a challenge. However, the director of packaging & logistics mentions that a complex world increases the value of networking activities. There could also be differences in company cultures, which could slow down or hinder progress. If the different business areas can understand each other it will ease the communication between them. It is according to the director of packaging & logistics always a process of give-and-take in order to create a win-win situation. This is also noted in the project of the case study, were the partnership was built on that premise. Similar approach is used by the company of senior associate principal scientist, which mentions that their projects often involve people that are specialist in communication and processes.

One could easily note in this chapter that there are fragmented opinions, and as many of the interviewees from research phase 2 are related to each other, and the company related to in research phase 3, problems could have arisen or arise in future project and cooperation. One has to regard partner selection one again here, were the partners has to join each other with common goal and vision. The partner selection process has to therefore include or at least align the partner's corporate and strategic alliance objective in order to take an initial step for a more successful outcome (Holmberg & Cummings, 2009; Duisters et al., 2008).

6.6 Planning tools

From the perspective of the R&D Company in the case study, the project was to deliver the foundation for an investment decision and pointing out different technological paths and opportunities which eventually could lead to a final

commercialization of a process. It was then up to other external actors to take the decision whether to make investments or not. According to Lee & Park (2004) it is essential to create an effective planning tool and process in order to be able to generate a foundation for taking managerial investment decisions regarding technologies and products.

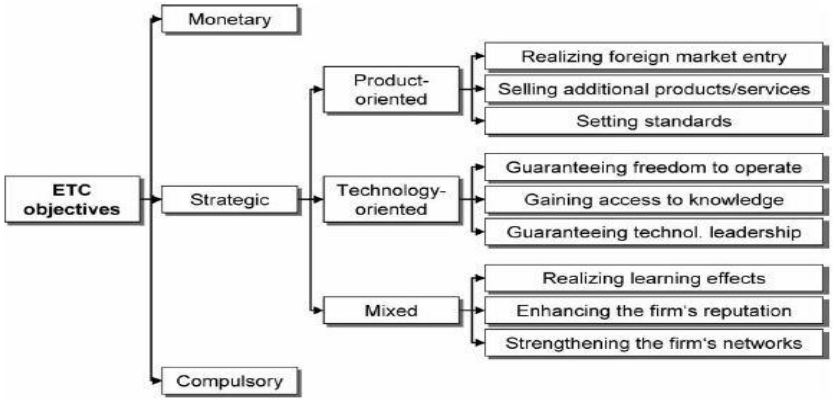

Figure 11. Illustration of strategic ETC objectives (Lichtenthaler, 2008)

One of the objectives of the case project was to strengthen the firm's network and exploring technology opportunities according to the senior research manager and business developer/project coordinator of the case study. Furthermore, according to systematization of Lichtenthaler's (2008), the main objective for the R&D company in the studied case project fall under the 'strategic' category and the technology oriented segment, which primary has the purpose of guaranteeing freedom to operate, gaining access to new knowledge, guaranteeing technology leadership, realizing learning effects, enhancing the firm's reputation and strengthening the firm's network. The interviewees of the project further explained that part of the planning process involved activities that lead to funding of a project and further mentions that in the previous project which the project in the case study was based on, consortiums was created which had the benefit of a gradual funding from several actors. Within the cluster program, the actors saw potential on further technology which could initiate the start of new projects. Bringing together results from a wide range of previous projects also lead to an increased interest from multinational company's within the process industry. Rinne (2004) puts emphasis on the importance to systematically capture ideas and keeping them alive as projects proceeds even though the specific ideas or technology is not used during that project. Those ideas or technologies can turn out to be valuable outside the context of the ongoing project by finding synergies with technologies of other firms. However, in the case project, the ideas was closely tied to experts within their technology areas and not formally documented which according to Rinne (2004) could hinder to see potential opportunities. The evaluation of technologies and ideas was also

performed exclusively in the phase before specific R&D activities was carried out. As product life cycles are shortened and technology advances rapidly Park & Lee (2004) underscores the potential value to frequently update the documentation of available technologies throughout the entire project.

One of the major steps in the planning process consisted of an evaluation of technological paths and opportunities. Technology roadmaps were considered to be extremely difficult to develop since the uncertainties of the project was perceived as high. Difficulties to adapt planning tools to uncertainties and environmental conditions has according to Lee & Park (2004) been one of the underlying reasons why the diffusion of technology roadmaps among firms in general have been relatively slow. This could be related to the project of the case study were the combined effect of the individual technologies was uncertain. However, the planning team had an overall sense of what the technology roadmap looked like. Since the project was funded by the European Commission it had low requirement on financial payback which made it easier to initiate the project and start the planning activities.

As many of the interviewed companies in research phase 2 had difficulties implementing technology roadmaps or used other planning tools, the company of the senior associate principal scientist had used it for several years and it was well implemented into the planning processes. A main benefit working with roadmaps is according to the senior associate principal scientist that it facilitates the startup process and the planning by easier identifying the next required step. Each technology within company 9's company has its own roadmap. All technology roadmaps can though be filtered into the same roadmap. The senior associate principal scientist mentioned 3D-printers and digital printers as an example where two roadmaps could connect. This goes well in line with the study by Rinne (2004) which found that roadmaps which cluster together technologies depending on their characteristic could be beneficial in order to find new applications and market opportunities.

In the planning phase of the project of case study, the R&D Company tried to avoid mistakes that had been made in the projects which were the foundation for the project of case study. In one of the previous projects, one of the actors had set the requirement to use a stage gate planning process if they would be part of the project. The stage gate approach lasted only for 6 months before the project participants realized that it was an approach that was not suitable for specific conditions of that particular project. The senior research manager of the case study was of the opinion that the Stage gate process was more suitable during product development projects rather than research and development projects focusing on the process innovation were it was hard to make a continuously evaluation based on a set of parameters.

The foundation for the project of case study had it origin from a result from a previous project which was not expected.

The interviews in research phase 2 indicate that planning processes including activities with several gates are accepted as a planning tool. By using a stage gate planning process requirements and criteria's in the different stages of a project must be fulfilled in order to progress, which could make the process more complex, especially when a lot of actors is involved in the project, with different people at different gates. In accordance with the senior research manager of the case study, the companies which had accepted the stage gate planning process however identified the combination of a need for a high level of flexibility together with a very specific timeframe of a project as a huge managerial challenge to overcome.

Another problem with a planning process which is based on evaluation of continuously delivering results is according to the senior research manager that it could hinder the research process by focusing too heavy on the specific parameter which the results are measured by. However, in contradiction to the senior research manager of the case study, the Vice President of a large multinational company points out that projects must be constantly proceeding. If a project is costly and not considered to have the potential to be profitable the resources must be allocated. It is common that when a project stands still people involved in that project tends to give empty promises time after time since they are personally committed to the project. This contradiction is identified in the study by Lichtenthaler (2008) and could be solved by putting great emphasis on the fact that projects with different objectives also requires different managerial approaches in all stages. Lichtenthaler (2008) further conclude that it could also be a problem among the project participants to agree upon appropriate measurements since they might have competences in different areas and value certain results differently.

Further disagreements on the planning of projects could be found by comparing the managerial approaches of the companies of the senior associate principal scientist and Vice president. The senior associate principal scientist mentions that freedom among the employees is of such importance for the innovation process that frameworks that should be followed could eventually hinder them. It is therefore difficult to combine the requirements on constantly delivering measurable results from R&D activities and the aim to be highly innovative and setting long term technology trajectories.

The project of the case study had from a planning point of view more similarities with software development which focused more on the overall purpose and aim of the project rather than figuring out the exact path from the beginning. The overall purpose was easier for the project participants to agree upon compared to how it

should be executed. These previous experiences from the planning phases of other project lead to the implementation of a SCRUM-based planning process.

Another reason why the project of case study did not use the previous stage gate model in the planning process was that it made it difficult to change direction during the project if an unexpected opportunity arises since. These unexpected opportunities could arise when paths that from the planning stage might have looked promising reached another result that was not expected which created new opportunities to build upon. This goes well in line what Rinne (2004) identifies as critical aspects to consider if the company should increase their innovation capabilities and control future technology trajectories.

By applying a SCRUM-like planning process in the project of the case study, it was easier for the participants to take advantage of unexpected results, exploit them and leave previous paths behind according the interviewees of the project. The final goal of the project was always considered more important than what was actually delivered in terms of technology or knowledge commercialization opportunities.

The process cost structure was one of the most important factors to consider during the project and especially during the planning phase. By analyzing the impact of different components and activities on the total price improvement suggestions could be made. Discussion in the planning phase had the cost structure as a base to figuring out technological alternatives to change the fraction between the components in order to lower the total cost without sacrificing product quality.

Comparing the results from the case project with the interviews in research phase 2, one could identify potential challenges that could occur due to cost and profit estimations in projects. According to several interviewees in research phase 2, miscalculations are most common from political instances and from those who allocates R&D investments, which could be a problem in a later stage. As a reference, one interviewee points out how researches makes mistakes by trying to estimate profits by only looking at the cost of input. As the cost of input is often a variable cost that in a best case scenario can be covered, while fixed costs are often overlooked. The same applies with other cost that arises in later stages of the value chain such as service, distribution, and potential switching costs, implying that profitability statements are done too glibly and that it is hard or impossible to make assumptions on costs and profits further downstream in the value chain. This could in the end lead to a loss of thrust between actors and partners in the value chain when expectations are not met.

Large investments are often required during product and technology development and to be able to make forecasts on future earnings the company must be relatively

certain about product performance. Low cost production and cost efficacy is not enough if the competitive environment is not included in the estimation of profits. The interviewees from a large multinational company of this research tend to argue that R&D companies in general should avoid making estimations of potential profits since it could eliminate margins for other actors in the value chain and in the end leading to unwillingness for other actors to collaborate with R&D companies. The Vice President of a large multinational company further explained that in the most extreme cases, the input cost (commodity input) has been higher than the value of the finished goods, remarking that ideas that are not anchored in a potential market application is from internal as well as external sources, and in some cases even from customers. The Vice president suggest that in order to determine if a product or technology is worth further analysis on its profitability, the value of the final product must be at least three times higher than the raw material costs. If that criterion is not met, further analysis is a waste of time independently of production efficiency.

Prior to the investment decision in the case study, a Pre-feasibility study, order of magnitude analysis, a pilot and demonstration test was performed. Part of the planning process also included determining what activities are needed to set up a pilot/ demonstration plants and to be able to analyze the results from these tests. Prior to demo testing ideas must be evaluated.

A challenge that occurred during the project of the case study was that the results from the pilot and demo testing were interpreted differently by different participants in the project. The analysis of the pilot testing will impact the planning process of the next set activities in the project. A reference product was created in the pilot testing and by trying to repeat that reference product the precision of the process had to be analyzed. The participants had different views on the analysis of the results from the pilot testing. A main question that had to be answered is whether the deviations from the reference product will increase or decrease in a full scale process.

Different perspectives and views of risk levels could be a potential problem when the opportunities are presented for the board members which are taking the final investment decision. According to the senior research manager of the case study, the process industry tends to be risk averse when new technology opportunities which are presented. If the higher management have low level of technological competence which could be a challenge to overcome when new processes are introduced. According to Lichtenthaler (2008) these knowledge asymmetries is a potential threat against a successful collaboration in external exploitation of technologies and knowledge.

7 Conclusion

The main findings from chapter 6 will be summarized and presented in this concluding chapter in order to answer the research questions:

- What are the challenges & problems in a planning phase that could occur for an R&D company during external technology commercialization?
- How could a R&D company potentially overcome challenges & problems in a planning phase during external technology commercialization?

Subchapter 7.1 and 7.2 will therefore provide concluding arguments for each research question.

7.1 Problems & Challenges

- Inability to see the potential of a certain technology or knowledge when it could be used in other than the company's core business or industry.
  - *Could hinder exploitation and collaboration opportunities.*

- No explicitly formulated approach to document unused ideas.
  - *Could lead to difficulties in project-to-project learning and hinder future valuable ideas to be captured.*

- Path dependence on current available technologies.
  - *Makes the company less flexible and able to find new applications.*

- It's a challenge to combine market initiated projects with research projects since the uncertainties of the research and development is high.
  - *Pay extensive attention to managerial implications and finding the appropriate balance of being able to investigating opportunities and delivering results.*

- Could be a challenge for companies to determine how far in the innovation value chain they have to go.
  - *Define the projects participants' role early in the planning phase and identify strengths and weaknesses among participants.*

- Imperfect knowledge and technology markets.
  - *Could make it difficult to deeply understand the resources and competences that other project participants offer. Pay attention to the creation of communication channels which facilitates mutual understanding.*

- Increase of the number of project participants.
  - *Sets higher requirements on coordination activities.*

- Difficulties to adapt planning tools to uncertainties and environmental conditions.
  - *Use planning tools which are highly flexible during all stages.*

- Cost and profit estimations related challenges in projects.
  - *Difficult to determine the required investment and potential profits. Get insights from companies closer to the market and define the objectives of the project.*

- Different interpretation of results by different participants.
  - *Communicate how the results from pilot- and demonstration tests are interpreted from the viewpoint of the specific company or institute.*

- Different perspectives and views of risk levels.
  - *Present potential risks early in the planning phase and align the risk level with the overall objectives of the project.*

7.2 Success factors

- Attaining knowledge, expertise and ideas internally within the company.
  - *Unused ideas that are well documented can be a source for future collaboration and exploitation opportunities.*

- Look for potential synergies.
  - *Potential synergies between small inventions could provide larger and more effective combined effect.*

- Thoroughly investigate potential for converting technology to profit opportunities.
  - *May facilitate funding of projects and create the foundation for future collaboration.*

- Consider goal setting with illustrative and expressive checkpoints.
  - *Facilitates the process of understanding the next required set of activities.*

- Categorize objectives explicitly.
  - *Makes the alignment between the company/institutes overall strategy and technology exploitation strategy feasible.*

- Explicitly formulated strategy of technology planning.
  - *Specific goals for certain technologies facilitate exploitation activities.*

- Be open minded and look for potential applications and solutions outside the own industry.
  - *Solutions may already exist in other industries and inspiration to start new projects could be found.*
  - *Utilize the diversity among employees with knowledge and experience from different companies in order to scout for external potentials.*

- Allow potential partners present their ideas and technology in order to facilitate opportunities for future collaborative projects.
  - *Makes knowledge transactions and transfer easier and creates understanding among project participants.*

- Design a strategic partner selection process.
  - *Creates a better synergy effect among project participants and makes collaboration with new actors feasible.*

- Consider roadmaps.
  - *Provides ability to cluster together technologies depending on their characteristic to find new applications, market opportunities and get an overview of technological trajectories.*

- Document meetings
  - *Document meetings in order to avoid conflicts if a partners deviates.*

- Encourage an active partnership.
  - *Long term collaboration makes mutual win-win situations possible.*

- Distinguish between monetary and strategic objectives.
  - *Make the project participants aware of the difference in order to avoid conflicts and misunderstandings.*

- Determine clear ownership of the project.
  - *To avoid conflicts regarding how the results of the projects could be used.*

- Not being limited to a predefined set of actors.
  - *Increases flexibility since unexpected opportunities can be exploited more efficient.*

8 Suggestions on Future Research

As the study of the thesis was delimited to the planning phase in external technology exploitation projects, further research could be conducted in identifying challenges and success factors in the succeeding phases which are closer to the actual commercialization such as the negotiation-, realization- and control phases of the five step model partially used in this research. Since the results from this study are based upon findings in a project which was focused on process development a similar study could be carried out in a product development project. Furthermore, this research has been carried out with a qualitative methodology and future studies could be approached with a quantitative methodology in order to cover the whole spectrum of divergent criteria's of credibility. An R&D institute's perspective has been taken throughout the study and perspectives of other participants with different roles could be further investigated.

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10 Appendix

10.1 Interview template 1

Company name:
Interviewed person:
Type of company:
Duration of interview:

General Questions

- What is your role within the company?
- What is your thoughts on technology innovation?
- Why is innovation important for your company?
- Where would you place your company in the value chain?

Planning

"The interface between corporate planning processes & the planning of external technology/knowledge exploitation"

- How do you formulate the strategy of technology planning?
- How do you evaluate the strategy of technology planning?
- How do you manage the interface between corporate planning processes and the planning of external technology exploitation?
- How do you manage the resource allocation?
- How do you pre-select technology customers?
- How do you plan for different forms of external technology exploitation?
    - Out-licence?
    - Joint venture?
    - Strategic Alliances?

Follow up-questions: **success factors** & **barriers? Give examples**

Intelligence

"Scanning the firm's technology environment/market"

- How do you scan the market for technological commercialization opportunities?
- How do you search for relevant patents?
- How do you identify information needs?
- How do you identify and evaluate different communication channels?

Follow up-questions: **success factors** & **barriers? Give examples**

Negotiation

"The contact point with customers and partners"

- How do you find business partners?
- How do you evaluate the counterparts?
- How do you create sufficient levels of trust between actors/partners?
- How do you set up collaborative agreements?
    - Do you define what the agreements should include before you meet potential business partners?

Follow up-questions: **success factors** & **barriers? Give example**

Realisation

"The execution of implementation tasks"

- How do you map the operational processes?
- How to you handle interface problems?
- Have you experience communication problems due to different views on a collaboration?
- How do you determine coordination requirements?
- What is your experience on the differences between internal and external projects?
- What has been most valuable and why?

Follow up-questions: **success factors** & **barriers? Give examples**

Control

"Controlling the activities inside and outside the firm"

- How do you redirect technology/knowledge transfer activities?
- When do you terminate activities?
- How do you enable learning effects?
- How do you analyze projects?
- How do you documents project and determine success factors?
- How do you measure success factors?
- How do you financially analyze a project?
- How do you allocate the profits between the collaborative actors?

Follow up-questions: **success factors** & **barriers? Give examples**

10.2 Interview template 2

Intervjuad person:
Företag:
Projekt:
Yrkesroll:
Intervjutid:

- Hur påbörjades projektet? Vem tog initiativet? Hur upptäcktes möjligheten?
- Beskriv planeringsprocessen i projektet. Hur formar ni strategiska planeringsprocesser för teknologin? Hur utvärderas strategin? Använder ni nån specifik strategi? Hur hittar/bedömer ni möjligheter för en viss teknik/teknologi? Strategisk teknologi planering utförs ofta med hjälp av interna planeringsverktyg, använder ni nåt sånt? Eller externa verktyg?
- Vilka företag är inblandade i projektet? Hur valdes dessa? Vilka egenskaper skulle dessa ha? Hur fördelades rollerna? Vem bestämde fördelningen?
- Vilken teknologi/produkt bidrar ditt företag med i detta projekt?
- Hur valde ni teknologi för detta projekt?
- Varför väljer ni att utnyttja externa partner för att kommersialisera teknik?
- Hur sätter ni upp mål för projekten? Vilka mål sattes för detta projekt? Hur enades ni om ett gemensamt syfte/mål?
- Vilken samarbetsform används i detta projekt och varför valdes denna? (joint venture, licensing, collaboration)
- Vilka och hur stora resurser lades på detta projekt? Hur bedömdes det?
- Vilka planeringsverktyg används i projektet?
- Hur används planeringsverktygen?
- Vilka risker identifierades i planeringsstadiet?
- Vilka risker uppkommer då företags teknik görs tillgänglig för externa aktörer inom projektet?
- Hur integreras teknikutnyttjandet i detta projekt med företagets övriga projekt?
- Hur identifierades kommersialiseringsmöjligheter i planeringsstadiet?
- Vilka kommersialiseringsmöjligheter identifierades?
- Hur identifieras potentiella slutkunder?
- Hur planerar företaget för att sätta en industristandard?