SEPAM Master Thesis

Date of Graduation 15-12-2014

PUBLIC VERSION

2014

Commercialization of project results in research public-private partnerships

AN EXPLORATIVE RESEARCH INTO PROJECT CHARACTERISTICS AND THEIR INFLUENCE ON COMMERCIALIZATION OF PROJECT RESULTS IN RESEARCH PUBLIC PRIVATE PARTNERSHIPS OF FP7

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1 Introduction

In 1995 the European Commission identified that the industrial performance of Europe is low compared to the scientific performance. This has been dubbed as the 'European paradox'. The competitiveness reports of 2011 and 2013 still show that the industrial performance is behind the scientific performance in Europe (European Commission, 2011, 2014c). This is shown in the reports by having better scientific performance in some sectors compared to Asia and US and worse or equal in other sectors, but the portion of the GDP that comes from knowledge-intensive industry is 40% compared to 50% in the US. It seems barriers exist for commercialization of research results in Europe. This is frequently called the 'Valley of Death' of innovation which is also identified as a problem by a high-level expert group of the European Commission (High-level expert group, 2011). This expert-group recommended that there should be more focus on the commercialization of research results in order to improve Europe's industrial performance.

Dosi, Llerena, and Labini (2006) investigated the European paradox identified in 1995 by the European Commission and came to the conclusion that the 'excellent' performance mentioned by the Commission is not that excellent at all. In fact they came to the conclusion that compared to the United States the scientific performance in Europe is worse or equal depending on the scientific field. They also criticize the linear nature of innovation in s the Green Paper on innovation (European Commission, 1995) which states a linear relation between scientific knowledge, technological innovation and their economic exploitation thereafter. Scientific exploration is not always the origin of innovations (Dosi et al., 2006). A famous example is the steam engine, which was used before scientists understood it. Even business models can be the source of innovation (Sorescu, Frambach, Singh, Rangaswamy, & Bridges, 2011). In this research project we acknowledge that the starting point of an innovation is not always technological development; it is the starting point which is focussed on in this research.

European research programs were in the past generally focussed on basic research. These programs shifted towards more applied and development research in the recent years to stimulate the commercialization of research results (European Commission, 2007b). This trend continued with the addition of Public-Private Partnerships (PPP) to the 7th framework programme in 2009 as a reaction to the economic crisis (European Commission, 2013a) and continues in the follow up of FP7, Horizon 2020 (European Commission, 2013a, 2014a). The PPP structure tries to strengthen key industries that were hit hard by the economic crisis. The PPP structure focussed on participation from the industry and exploitation of project results (European Commission, 2013d).

This research project will focus on overcoming the Valley of Death by identifying factors which have an influence on the commercialization of European research results, this research can be used by the European Commission to improve future research programmes. This is the **societal relevance** of the project. Extensive research is done in the field of commercialization of technology, however this is most of the time done from the perspective of a specific organization. This research focuses on a consortium as research object. Factors of interest are composition of research and innovation projects and the properties of the scientific and technological field of the research projects. If more is known about what factors and conditions influence the commercialization of research results, it is possible to better 'fit' the consortium with the research project to increase the probability that research will be commercialized.

Empirical data is collected in collaboration with Technopolis-group. Technopolis-group is Commissioned to evaluate a part of the 7th framework programme, the Nanosciences, nanotechnologies, materials and new production technologies (NMP) theme. This theme is interesting as it is the overarching theme of the PPPs. Three topics fall under the PPP's: Green cars (GC), Factories of the future (FoF) and Energy efficient buildings (EeB). These PPP topics are successful in involving the private sector. Industrial participation in the PPPs is 57% compared to 34% in other FP7 projects (European Commission, 2013a). Data collected in this evaluation is available for this research project.

Before reading on the definition of innovation needs introduction. The term innovation is a broad one and in this research project the definition that is stated in the OSLO manual (OECD, 2005, p. 46) is used. "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." This is essentially the same as the term commercialization of research results used in this proposal.

1.1 Research problem

1.1.1 The 'Valley of Death'

The Valley of Death is a term for the troublesome transition from research to innovation (Auerswald & Branscomb, 2003; Barr, Baker, Markham, & Kingon, 2009). The reason for the existence of this valley is an institutional, financial and a skill gap (Barr et al., 2009). The financial gap relates to the amount of funding available for further development of the technology that is needed before it can be commercialized. In earlier stages of development, there are resources available for research from universities, research institutes, government and companies. In later stages of development, there is funding available in the form of venture capital, equity and commercial debt (Auerswald & Branscomb, 2003). Between these two levels of development lies the financial gap. The skill gap is related to the set of skills needed to overcome this gap. The further a technology develops the more commercial or business skills are needed (Auerswald & Branscomb, 2003). The institutional gap relates to the lack of formal institutions that support and enable activities in this phase of technology development (Auerswald & Branscomb, 2003).

Because of the existence of this valley, the performed research projects not always realise/attain their market potential. The European Commission also sees this as a problem. The Commission tries to overcome this valley and the weak position of the European industry by including more private companies in European funded research. This is implemented by adding a public private partnership (PPP) structure in FP7 as part of the European economic recovery plan (European Commission, 2013d). In the final assessment of these PPPs it is recommended that the focus should be more on close to market research and on projects with a higher technology readiness level (further developed technology) (European Commission, 2013d). The PPP's are expected to overcome the gap as they fill the financial gap in the form of funding for research, the skill gap by including both research and industrial parties and the institutional gap by providing the enabling infrastructure. The EC wants to overcome this valley by stimulating commercialization of research within the FP7 programme by introducing the PPPs.

Scope of FP7-NMP:

- 875 Projects funded
- Initial budget €3,5bln
- 377 PPP projects funded
- PPP budget €1.6bln of which €710mln specifically for NMP

1.1.2 Commercialization strategies

To commercialize research, three common strategies are used: university licensing, launching an academic or corporate spin-off or a company bringing the technology to the market. These three strategies are well founded in literature already. The motivation for using each of these strategies differs. Licensing a technology from research to industry is one of the most common strategies (Thursby & Thursby, 2011). This is a way for universities to create revenue from their research activities (Thursby & Thursby, 2011). However the technology has to be mature enough for this strategy to work or else the risk for private companies is too high (Ford, Koutsky, & Spiwak, 2007).

The second strategy, spinning off, is a strategy used both in the academic sector as well as in the private sector. An academic spin-off is "a new company based on the findings of members of a research group from academia" (Festel, 2013, p. 455). Usually these spin-offs are based on technology that still needs further development before it can be introduced to the market and are based on a high degree of tacit knowledge (Shane, 2004). If successful, this is a strategy that overcomes the Valley of Death (Shane, 2004). The downside of an academic spin-off however is that financing is hard to come by, because of the early stage of development of the technology (Ndonzuau, Pirnay, & Surlemont, 2002). A corporate spin-off is a "new business based on research and development done within a (larger) parent firm" (Parhankangas & Arenius, 2003). A common reason for spinning off is that the discovered technology does not fit the strategy of the firm financing the research (Chesbrough, 2003a). Most of the time the spin-off will be launched when a firm decides to restructure (Parhankangas & Arenius, 2003), spinning-off is in that case chosen in favour of closing down research on this technology (Festel, 2013). The benefit of a corporate spin-off over an academic spin-off is that the parent company can help finance the start-up phase of the spin-off, this is generally harder for an academic spin-off (Festel, 2013).

The last strategy is a private company bringing the outcome of research in the market. This is done when the technology fits the core business of the company and is of low enough risk. When this strategy is used, the Valley of Death has already been overcome. The problem lies in the phase preceding commercialization.

1.1.3 Commercialization in research and innovation projects: the scientific relevance

While there is a lot known about how private companies and universities commercialize research, there is a **knowledge gap** in scientific literature. Commercialization research is usually done from the perspective of a single entity, whereas the research activity is done in collaboration with diverse partners. The collaboration and open character of innovation is one widely researched (i.e. Chesbrough, 2003b). Little is known about how research partnerships (plan to) commercialize the research done in these projects. As part of the European Economic recovery plan the European Commission launched a public-private partnership initiative within the 7th framework programme, most of these projects fall under the NMP theme (European Commission, 2013d). The public-private partnerships involve more industrial partners than 'regular' FP7 projects. The motivations for adding these PPPs to FP7 are to strengthen the European industries in key areas and to steer more towards commercialization of research results (European Commission, 2013d).

One can expect that when a consortium mainly exists of research partners, then licensing or an academic spin-off will be the most prevalent mechanisms used to commercialize research, while the opposite is expected when industrial partners dominate a consortium. In that case it is expected that the companies will launch the products as part of their business or launch a spin-off if it does not fit their current business.

The **Scientific relevance** of the project will be from the perspective of the research partnership, instead of a single organisation, **in relation with commercialization of project results** as this is not researched extensively as of yet. Furthermore this is the first research that focuses on a new structure introduced for research and innovation projects funded by the European Commission which is focussed on commercialization of the research results.

In FP7, there are two type of project common. Large integrating projects (IP) and small to medium scale focussed research (FP) projects. The integrating projects have a broader scope than the focussed projects and are usually very ambitious. The integrating projects have a 'programme' like structure and can include many activities. The focussed projects have a more limited scope and focus on research, technological development and/or demonstration activities. Both are collaborative projects focussed at developing new knowledge, new technology, products, demonstrators or common resources for research. In this research the scope of the projects will be taken into account when looking at commercialization of project results

1.1.4 Technological context

This research explores the influence of the technological context on commercialization of research results in collaborative research projects. This is done because different technologies can have different challenges. An example can be that the technology first needs to be adopted in a standard before commercialization or that the technology was not mature enough for market exploitation. To compare different context the perspective of Technological Innovation Systems is used. This is defined as "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilization of technology" (Carlsson & Stankiewicz, 1991, p. 111). This perspective is different from the national systems of innovation. It focuses on an area of technology instead of all technological areas on the national level, because the boundaries of a technological area do not always coincide with national boundaries and it puts a greater emphasis on micro-economic aspects as it focuses on the problem of adoption and utilization of technology. (Carlsson & Stankiewicz, 1991). The motivation for the choice of this concept can be found in 2.4. This perspective focuses on the 'system' in which the technology is imbedded, which makes it a good choice for explaining the context.

The structures of a technological system of innovation are what forms the context in this research. Bergek, Jacobsson, Carlsson, Lindmark, and Rickne (2008) made an overview of these structures and identified three categories: Actors, Institutions and Networks. The actor category relates to any organisation contributing to the emerging technology. Through their choices and actions technology is generated, diffused and utilized. The institution category is commonly considered the 'rules of the game'. These institutions can be both from a formal (rules/regulation) or informal nature (tacit, norms, values). Networks are formal and informal structures for a specific purpose, formal can be a standardization network, while buyer-seller relationships can also be considered a network.

Hekkert, Suurs, Negro, Kuhlmann, and Smits (2007) contributed to this area by identifying what the functions are of technological innovation systems. These are *Entrepreneurial activities, Knowledge development, Knowledge diffusion through networks, Guidance of the search, Market formation, Resource mobilization* and *Creation of legitimacy.*

This research will take into account the technological context of the research projects. Is there an influence of the technological context on the commercialization of research results? And can that be explained using the technological systems of innovation concept?

1.1.5 Deliverable

The outcome of the research is to make a first indication what the influence of consortium characteristics are on the commercialization of project results and the strategy used to achieve this. Hereby we take into account the technological context of the projects by looking at the specific technological innovations systems. The aim is to construct a conceptual model which shows the relations between Consortium characteristics, technological context and commercialization of research results. The European Commission can use this model to make better decisions on the structure of research and innovation projects within EU funded research programmes, taking into account the technological context.

1.2 Main research question and sub-questions

What consortium characteristics of research and innovation projects, when taking into account the technological context, stimulate or hinder commercialization of these projects?

8 sub-questions have been formulated in order to answer the main research question:

- What does the literature say on consortium characteristics and their influence on research and innovation projects?
- What does the literature say on commercialization of the results of research and innovation projects?
- Which theoretical concepts help to explain differences in technological context?
- Which commercialization activities and strategies are used in European research and innovation projects?
- What consortium characteristics affected the commercialization activities?
- What is the influence of the technological context on commercialization of research results in research and innovation projects?
- How does a conceptual model look like that shows what the relation is between commercialisation of project results and project characteristics taking into account the technological context?
- How should future research and innovation consortia be designed in order to achieve a higher rate of commercialization of research results?

The relationship that we focus on in this research is visualized in Figure 1

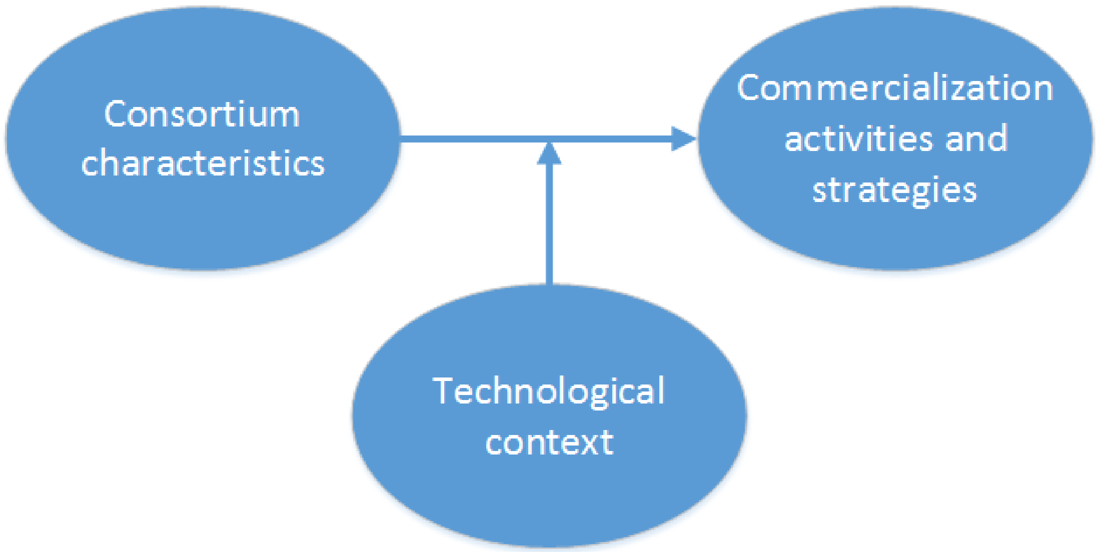

Figure 1: Research visualization

1.3 Research Methods

The chosen research method is literature research for research questions 1, 2 and 3, case study research for the questions 4, 5 and 6. Analysis of the case-study results should give answer to questions 7 and 8. Case-study research is used because the project is exploratory in nature and in a relatively unknown domain. Multiple case-studies will be performed in collaboration with Technopolis-group. For this project 10 case-studies will be performed. This research has ties with the FP7-NMP evaluation performed by the Technopolis-group, in which 51 case-studies will be performed, where these 10 are also part off.. According to Yin (2009) case study research is suitable when a study emphasizes on key mechanisms, where the researcher cannot control the outcome and when the research is done on current issues. The 10 case-studies were being performed in de months of May and June 2014. Yin (2009) also identified drawbacks of the case study approach. The first is the lack of rigor, the case study researcher needs to ensure that his results are not subject to bias. Furthermore, it is hard to generalize results to all projects based on a case-study, by doing 10 different case-studies this drawback is minimized. For each of these case-studies the case-study protocol as defined by Technopolis-group is used (see Appendix D). To analyse the results, Excel will be used. In Excel the different cases can be easily compared with the help of filters. Strong findings and relations will be further explored in the actual text of the case studies. Here the underlying motivations or relations will be explored. In the end all findings will be visualized in a conceptual model.

1.4 Data

Access to the interviewees is arranged by the Technopolis-group as part of the FP7-NMP evaluation. The sampling of 51 projects for the evaluation was performed by me within this master thesis project. 10 of these projects were further analysed by me. These 10 case-studies are all public-private partnerships. This is done because these projects are more likely to be close to commercialization and are thus more suitable to give the information that is needed to answer the main research question. The 10 case-studies were performed on the following 10 projects further information can be found in chapters 3 and 4:

E-Hub	Harwin	Nanocool	Easee	Streamer
Phocam	Harco	Hi-Micro	Eneplan	Fasion-able

1.5 Research design

The structure of this research is visualized in Figure 2. This design shows in an overview where the research questions are answered (visualized in yellow) and where output of research is used in following chapters.

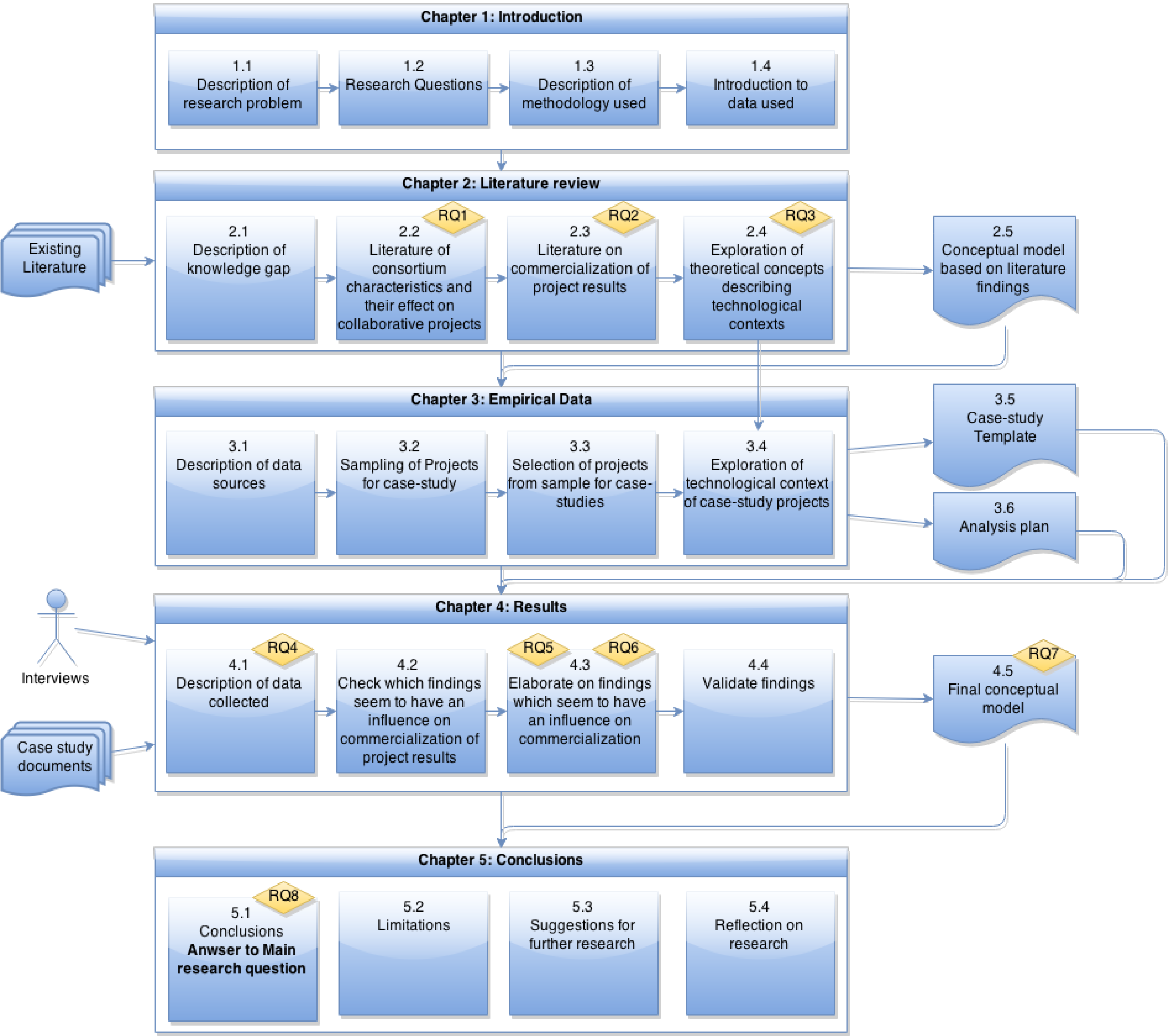

Figure 2: Research Design

2 Literature Review

In this chapter the model (Figure 1) from the first chapter are explored in literature. Literature on consortium composition of research projects, commercialization of research results and the link between those are explored. After that the technological domain will be investigated and the influence on the commercialization of research results by consortia. At the end of this chapter the conceptual model is expanded with the findings from the literature.

In this chapter the following research questions will be answered:

- What does the literature say on consortium characteristics and their influence on research and innovation projects?
  - This question will be answered in 2.2
- What does the literature say on commercialization of the results of research and innovation projects?
  - This question will be answered in 2.3
- What theoretical concepts help to explain differences in technological context?
  - This question will be answered in 2.4

The answers to these questions will be used to expand the conceptual model, which is one of the deliverables of this research.

The methodology used for the literature research is to use combination of keywords for each part of the literature keywords. When a useful source is found, the references in the source are quickly scanned for usefulness and the same is done for sources citing this source. Search engines used to find the articles were Google, Google Scholar, Web of Science and Scopus. Some sources used in the research were suggestions by members of the graduation committee.

For consortium composition, combinations of the following terms is used. Collaborat*, research, project, university-industry, "technology transfer", consorti*, commercialization OR exploitation.

For commercialization combinations of the following terms are used: "Valley of Death", "European paradox, Innovation, Commercialization OR Exploitation, consorti*, spin-off, "academic spin-off", "corporate spin-off".

For the models describing the technological context the following terms are used: "innovation system*" OR "system* of innovation", technolog*, "cyclical innovation model", "triple helix"

2.1 Perspective in current literature

There are several streams of innovation literature. The main ones related to the subject of this research are Open Innovation, Management of Innovation and Systems of Innovation. These streams are shortly described in order to show that the perspective chosen, that of a project, not from the perspective a single organisation, is not researched extensively as of yet.

2.1.1 Open innovation

Open innovation is a stream that became large in 2003 by the work Henry Chesbrough. The basic idea is that firms that adopt open innovation do no longer innovate in a solitary context, but they rely on input from other organisations (in the form of licensing or purchasing) and other organisations build on the innovations by the firm (Chesbrough, 2003a). Open innovation can be both inbound and outbound, where inbound open innovation is the one most used by firms (Huizingh, 2011). Inbound innovation means that organisations use technology from other organisations and outbound is making technology available to use for others. While the open innovation literature focuses on alliances and collaborations, it is mostly focussed on the perspective of a single organisation, for example how an organisation can successfully implement open innovation or why open innovation doesn't work in some firms (Huizingh, 2011). Or the focus is on the use of open innovation in specific sectors (Huizingh, 2011). The open innovation literature does not use the perspective of a consortium, on which this research focuses, as the nature of open innovation is from the perspective of a single organisation. Therefore the open innovation literature will not be considered to construct the conceptual model.

2.1.2 Management of innovation

New technologies often fail to be launched on the market as products or services and when they do, they often do not turn into a commercial success (Tidd, Pavitt, & Bessant, 2001). Often this is due to the management of innovation. Using innovation management a firm can use external and internal opportunities to introduce new ideas, processes and products (Kelly & Kranzberg, 1978). The literature on Innovation Management also uses the perspective of a single firm. They do however focus on collaboration with other organisations, but this is still done from the perspective of a single organisation. In this research the focus is on the level of a research and innovation project where multiple partners with different roles are represented. In the management of innovation literature the perspective of the company is chosen, why and how a company should collaborate in order to get innovative gains.

2.1.3 Systems of innovation

One of the perspectives in the system of innovation approach is the National Innovation System approach and another one is the Technological Innovation System approach. The difference between these two approaches is the boundary of the system. In the national system of innovation approach this lies at the geographical border of a country while in the technological innovation system the technology is the boundary, which can traverse national boundaries. A national system of innovation is constituted of "elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and (…) are either located within or rooted inside borders of a national state" (Lundvall, 2010, p. 2) . The definition of a technological system of innovation is "a network of agents interacting in the economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology" (Carlsson & Stankiewicz, 1991). In the technological innovation approach two aspects are captured, the structural characteristics and dynamics. The structural parts are defined as actors, networks and institutions (Bergek et al., 2008). The dynamics of the system are described as functions of innovation systems (Hekkert et al., 2007). The systems of innovation approach is useful in covering the context of research and innovation projects but do not cover the subject of this research as it gives an overview of the whole system and not one research and innovation project. Other approaches are the regional innovation system perspective which looks at differences between regions (Agrawal, Cockburn, Galasso, & Oettl, 2014) or sectoral innovation systems which has a specific sector as system boundary a specific sector (Malerba, 2002)

2.2 Consortium characteristics

This paragraph will explore the following research sub-question: What does the literature say on consortium characteristics and their influence on research and innovation projects?

The body of knowledge on consortium composition of research projects is very light in the scientific literature. However there are some indicators on the influences of collaboration between different partners not directly related this research. This gives an idea what the influences on consortium composition might be. At the end of this paragraph influences of consortium composition on research projects will be mapped and visualized. In this paragraph the collaborative research literature will be explored to find factors that are of influence on the performance of research and innovation projects. Because this research focuses on collaborations that include both industrial as research partners, the university-industry relationship literature is also explored. Lastly the literature is explored to find the influences on including a specific partner and the influence of the number of partners in a research and innovation project.

2.2.1 Research productivity in collaborative research

A lot of the literature is focused on productivity in research collaboration. For example Beaver and Rosen (1979), investigated productivity as a function of co-authorship, Landry, Traore, and Godin (1996) study research collaboration with a questionnaire and an econometric model to find if collaboration between partners of different kinds (academic and industrial) increases research productivity (publications and other outcomes compared to the time and resources the projects have). They found that collaboration, whether between academia or in collaboration with industry increases research productivity. Godin (2003) did research on the influence of funding on research productivity. The author found that funding correlated with increased research productivity. Lee and Bozeman (2005) found that funding has a positive influence on productivity because of the access it provides to research resources. Collaboration on research is important as they increase the division of roles and tasks in the project, a single researcher does not always have all the necessary knowledge and skill for a research project; collaboration ensures that a diversity of knowledge and skills are available in the project (Katz & Martin, 1997). This is one of the aims of the European FP7 programme: to bring together resources for high-end research where resources from different countries and disciplines are needed, which generally are hard to come by on a non-European scale (European Commission, 2007a). The body of knowledge is mostly focused on outputs such as patents, papers and other easier to measure output. In this research the focus is on commercialization of the technology, which is not covered much in the literature on research collaboration.

2.2.2 University-industry relations

Another part of literature related to this project is the collaboration between university and industry. In this area also a lot of research has been performed. Universities are more and more stimulated by policy makers to foster links to industry and facilitating technology transfer (Etzkowitz, Webster, Gebhardt, & Terra, 2000). Technology transfer from university to industry is stimulated by policy makers to maximize the return on the public investment on research performed by universities (Markman, Siegel, & Wright, 2008). This is important as considerable funds are spent on research and at the same time the amount of funds available are limited while researchers indicate that more funding is needed for research (Salter & Martin, 2001). To support this, universities use institutional structures such as technology transfer offices and incubators (Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005; Siegel, Waldman, & Link, 2003). Incubators support university industry links by supporting the academic spin-offs. Technology transfer offices of universities facilitate technology transfer to industry by means of licensing of intellectual property rights of university research deliverables. A lot of research has been performed on technology transfer from science to industry, however when public research is performed where industry and academia collaborate, there is little literature on the commercialization or transfer to industry of this technology. What can be learned from this topic is to look for factors which hinder or enable successful collaboration between universities and industry partners within collaborative research projects. These factors could also be applied to the cases in this research.

Fontana, Geuna, and Matt (2006) did research on factors affecting the university industry-relationship. They identified in literature and their research that the firm size is one of the factors influencing the likelihood of firms to collaborate with universities or other public research organizations. Usually larger firms or start-ups are more likely to benefit from academic research because large firms spend more on R&D and spin-offs are likely to originate from large companies or universities (Cohen, Nelson, & Walsh, 2002). Furthermore they found that when the R&D activity of a firm is higher, the firms are also more likely to engage in research projects with public research organizations, the same is also true by the degree of 'openness' of the firm. Openness is defined as the set of activities firms conduct to acquire knowledge from, share knowledge with and/or exchange knowledge with external parties. The type of innovation (i.e. product or process innovation) did not have an influence on the likelihood to collaborate. Fontana et al. (2006) note however that the relationships between firms and public research organizations are heterogeneous, and that differences between sectors are present.

Barbolla and Corredera (2009) analysed collaborative projects and contract research between university and industry. The authors investigated factors leading to success or failure of the projects. They based this research on data gathered during interviews with university researchers. They found that the most successful projects keep the project simple. With simple is meant that the scope of the project is clearly defined and that the role of each project participant is clear from the beginning. They found that projects involving numerous stakeholders usually have more difficulties during the course of the project, often/mainly due to internal relationships that did not work. Reasons for difficulties are objectives of partners that are different, the group is too heterogeneous or there are managerial difficulties. The authors note that leadership is crucial in these cases. Another factor they identified is financing. Corporate financing leads to a higher awareness of project needs. They indicate that a significant corporate contribution is more likely to lead to project success than purely subsidized projects. In their paper the most important triggers for project failure were technical difficulties, insufficient funding, inadequate human resources and unclear project definitions (p. 611). The objectives of failed projects were mostly not feasible because of technological risk or immaturity. All factors that Barbolla and Corredera (2009) found for success or failure are visualized in Figure 3.

For this research this means that the use of mature technology will be taken into account in the technological context, that the scope and roles of a project should be clearly defined and that the amount of corporate financing should be taken into account.

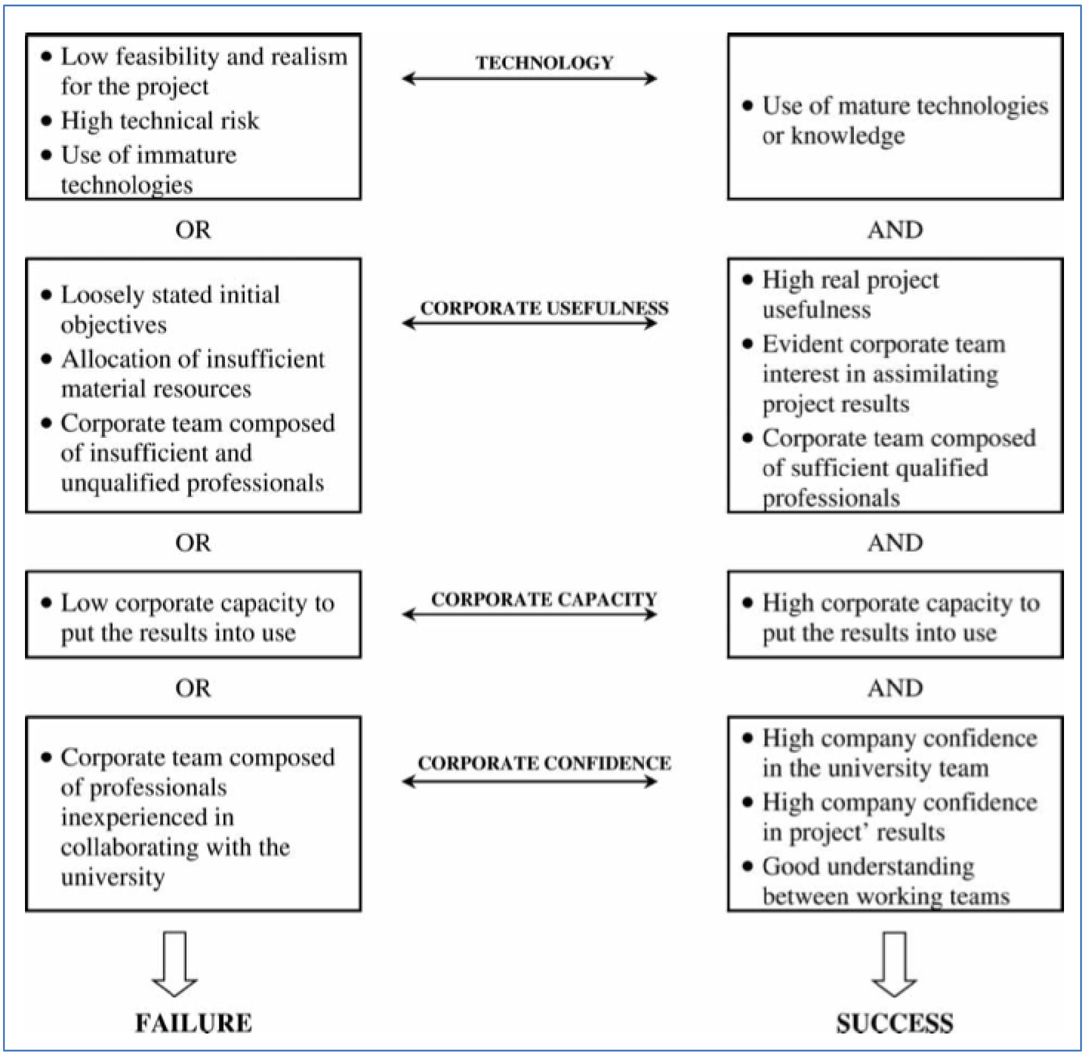

Figure 3: Model of success factors of university-industry research projects (Barbolla & Corredera, 2009, p. 612)

2.2.3 Partner diversity

Projects that are issued under the Factories of the Future and Energy efficient buildings flag are contractual Public Private Partnerships (PPP) which use the same funding rules of the 7th framework programme (FP7) (European Commission, 2013d). This implicitly means that the project partners are not of one nature, both industrial as well as public organizations must be participating in a research project to be eligible for funding. In this paragraph the literature on partner diversity in research projects is explored.

Raesfeld, Geurts, Jansen, Boshuizen, and Luttge (2012) explored the influence of partner diversity on the commercialization of technology developed in public research and development projects. They did this research on the nanotechnology sector in the Netherlands. They noted that there is a lot of research done on the establishment of links between university and industry but not what the nature of the influence of these links on research projects. Their study is based on research done by Petruzzelli (2011), who explored the influence of technological relatedness of firms and university, prior collaboration and geographical distance on the relevance of the collaborations. Petruzzelli (2011) discovered that technological relatedness follows an inverted U curve, for relations to be effective the partners should operate in fields that share basic knowledge but have different knowhow on the specialized level. The author also found that prior collaborative experiences make the linkages more valuable. Geographical distance was not affecting the quality of the links between university and industry.

Raesfeld et al. (2012) could not find the same inverted U curve as Petruzzelli (2011), however they did find that value chain complementarity (partners in a project in that operate in the same value chain) has a positive influence on both the application development and the commercial performance. is in line with earlier research. Miotti and Sachwald (2003) also found that industrial firms are more likely to collaborate with suppliers or clients in research projects to pool resources and to better target innovation efforts. These authors also found that collaboration with value chain partners stimulates the introduction of innovations to the market. Nieto and Santamaría (2007) confirmed this finding and have shown that collaboration on technology with competitors has a negative influence on the collaboration. It has a positive influence however when competitors are performing basic research, establish standards or other activities beyond a single company's influence. These authors also found that collaboration between firms and research organisations stimulate innovation. The authors concluded with a notion that collaboration with diverse partners is a success factor in research projects. From the perspective of SMEs, the literature also finds that SMEs benefit the same way from collaboration within the value chain and with research organizations as any other firm (Zeng, Xie, & Tam, 2010).

2.2.4 Size of consortia

One of the possible influences on research projects and their output is the size of the research and innovation projects. In paragraph 2.2.2 it was already mentioned that involvement of numerous stakeholders has a negative influence on the research projects (Fontana et al., 2006). There is little evidence in the literature on the influence of consortium size or the number of partners in a research project. As already mentioned in paragraph 2.2.3, collaboration with other partners increases productivity and chances of a successful project. However, one can imagine that when the number of partners is very large, coordination issues can arise thus making the collaboration more troublesome. In the interim evaluation of FP7 the difficult project management of large consortia was also identified as a problem (Annerberg et al., 2010).

There is one paper in the literature one large research and innovation projects which concludes that larger consortia are not effective in developing specific products ready to the market (Vonortas & Spivack, 2006). Instead Vonortas and Spivack (2006) found that larger consortia are more suitable to bring the state of the art of technology further and to develop standards. Vonortas and Spivack (2006) also found that in larger consortia management of the project becomes very important. Too little or too much management both make that partners feel left out of the decision making process or have a vision that the distribution of power is unfair. Equilibrium of management is needed to avoid this.

2.2.5 Summary and implications

To summarize the current findings on the influence of consortium composition, in 2.2.1 we presented that research productivity increases when parties collaborate on research (Landry et al., 1996). Funding is also of influence in research productivity. Generally more funding means more research productivity (Godin, 2003). The increase in productivity can be explained by the pooling of research resources, it is rarely the case that a single researcher has all knowledge and skills needed in the research project (Katz & Martin, 1997).

In 2.2.2 we found that university-industry collaborations are being stimulated to facilitate technology transfer (Etzkowitz et al., 2000) to maximize the return of public investment in research (Markman et al., 2008). A lot of research has been performed on university-industry collaboration, but not on how research partnerships commercialize the technology, however factors for success or failure can be identified. Larger firms and start-ups are more likely to collaborate with public-research organizations than other firms (Fontana et al., 2006). The type of innovation has no influence on the likelihood to collaborate (Fontana et al., 2006). When the project is kept simple in terms of clearly defined roles of partners and has a well-defined scope, the project will be more successful (Barbolla & Corredera, 2009). Corporate financing is also one of the success factors as it increases the awareness of the project (Barbolla & Corredera, 2009). Factors for failure are technical difficulties, insufficient funding, unclear project definitions or inadequate human resources (Barbolla & Corredera, 2009). Figure 3 visualizes factors for success and failures.

In 2.2.3 the influence of the diversity of partners in research projects is explored. It is found that partners should be technologically related on the basic level but should differ on the specialized level for effective collaboration, following an inverted U curve (Petruzzelli, 2011). Including partners in the value chain is also a positive factor for both application development as well as commercial performance (Miotti & Sachwald, 2003; Nieto & Santamaría, 2007; Raesfeld et al., 2012). Working with competitors has a negative influence on the project (Nieto & Santamaría, 2007). SMEs benefit the same way from collaboration with value chain partners and research organizations and other firms (Zeng et al., 2010).

In 2.2.4 the impact of consortium size was explored. Not much literature can be found on this topic but generally it means that collaboration on research has a positive influence until the number of partners gets too large because of project management issues (Annerberg et al., 2010; Fontana et al., 2006; Vonortas & Spivack, 2006).

To summarize, all findings from the literature review are visualized in Figure 4 This is done to give a quick overview on the literature of project characteristics on research and innovation projects. No direct link with commercialization is identified in literature.

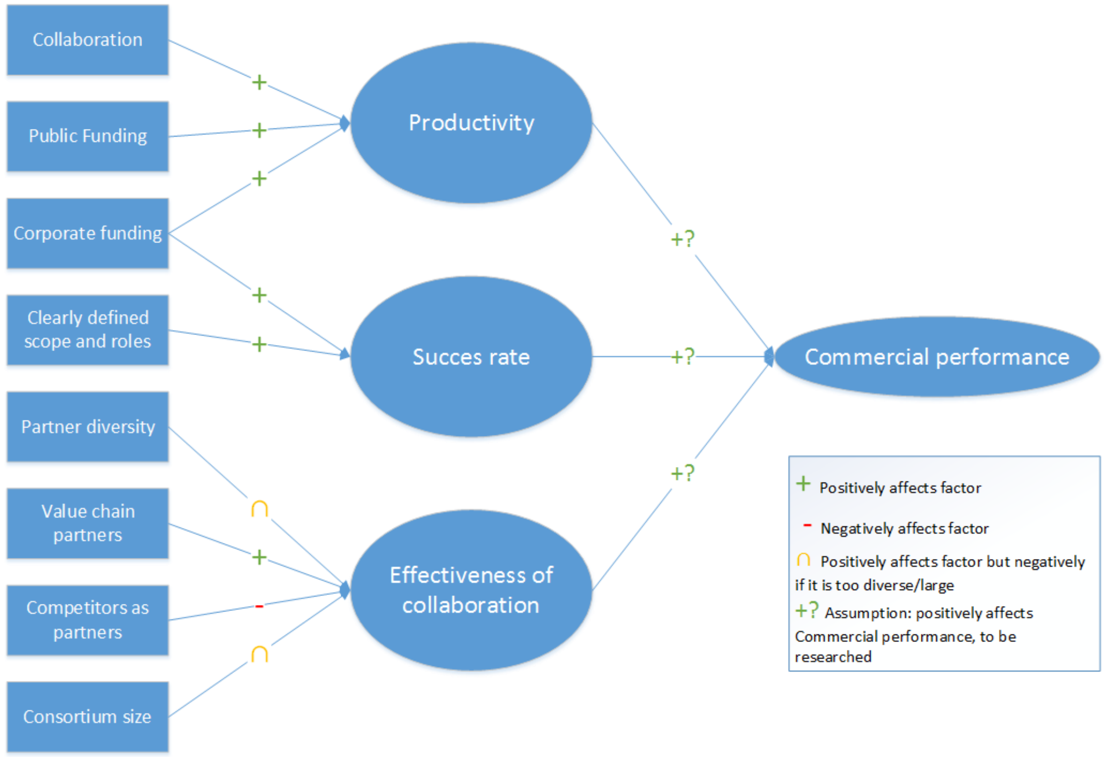

Figure 4: Findings from literature visualized, influences of consortium design on commercial performance

2.3 Commercialization of research results

This paragraph will answer the following sub question: What does the literature say on commercialization of the results of research and innovation projects?

This research focuses on the commercialization of research results done in consortia funded by FP7. To learn how research is being commercialized. literature research is done on the current strategies being used to commercialize research outcomes, what the difficulties are to commercialize research and what can be done to overcome this. But first literature focused on the problem, the Valley of Death, will be further explored. At the end of this paragraph it is known why technologies are or are not commercialized and why and when certain commercialization strategies are used.

2.3.1 The 'Valley of Death'

The Valley of Death is a term for the troublesome transition from technology researched and developed into marketable innovations. (Auerswald & Branscomb, 2003; Barr et al., 2009). The reason for the existence of this valley is an institutional, financial and a skill gap (Barr et al., 2009). The financial gap relates to the amount of funding available for further development of the technology that is needed before it can be commercialized. In earlier stages of development, there are resources available for research from universities, research institutes, government and companies. In later stages of development, there is funding available in the form of venture capital, equity and commercial debt (Auerswald & Branscomb, 2003). Between these two levels of development lies the financial gap. The skill gap is related to the set of skills needed to overcome this gap. The further a technology develops the more commercial or business skills are needed (Auerswald & Branscomb, 2003). The institutional gap relates to the lack of formal institutions that support and enable activities in this phase of technology development (Auerswald & Branscomb, 2003).

There is no single definition of the Valley of Death. According to Auerswald and Branscomb (2003), the Valley of Death exists between invention and product development in a phase they called early stage technology development. This is the stage where the technology shifts from a research practice to an industrial practice. Venture capitalists will take the risk investing in the new technology once the technology passes this phase. While researches interested in the technology will be funding the early stages of development.

Murphy and Edwards (2003) also state that the valley is around (early) development of technology. This is in line with the findings of Auerswald and Branscomb (2003). The Valley of Death according to Murphy and Edwards (2003) is visualized in Figure 5. Here can be seen that when the concept of the technology is proven, the risk is still too high for venture capitalists to invest in the technology, because venture capitalists like to invest in the technology when it has reached the phase of early commercialization (Murphy & Edwards, 2003).

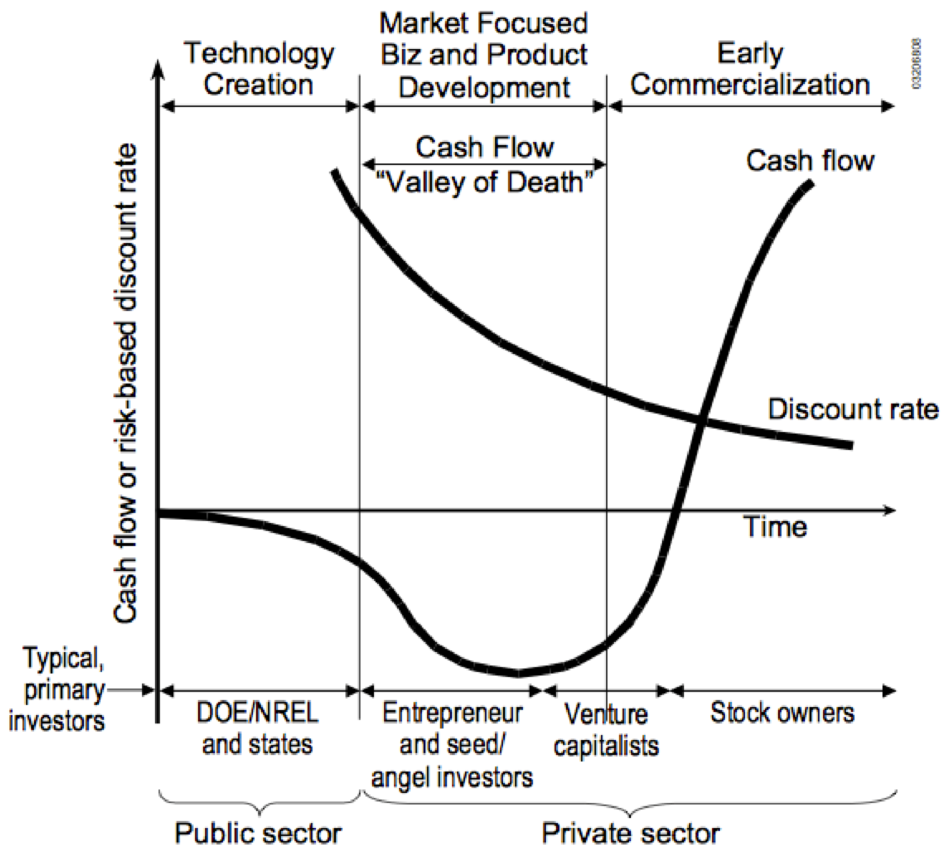

Figure 5: visualization of the Valley of Death according to Murphy and Edwards (2003, p. 3)

House of Commons: Science Technology Committee (2013) identified the valley as a gap between the prototyping phase and the scaling-up phase. According to the Committee the Valley of Death is a point at which a technology based business has a working prototype that needs further development. At this point the technology is not developed far enough to earn money through commercial sales and needs other sources of income.

The High-level expert group (2011) on key enabling technologies identified the valley spanning all the way from basic knowledge generation to the subsequent commercialization of this technology into marketable products. This is due to the absence of pre-commercial R&D support. According to the High-level expert group

(2011) crossing this Valley of Death requires that three pillars are needed to cross the Valley of Death:

- The technology research pillar, providing technological facilities supported by a research technology organization.
- The product development pillar, this pillar provides pilot lines and demonstrators that are supported by industrial consortia
- The competitive manufacturing pillar, this pillar provides support for competitive manufacturing by anchor companies (key companies located in Europe)

The Valley of Death according to the High-level expert group (2011) is visualized in Figure 6.This research focuses on the research public private partnerships of FP7 which stimulates consortia to develop pilots and demonstrators of technologies. Meaning that this research is focused on the second pillar of product development.

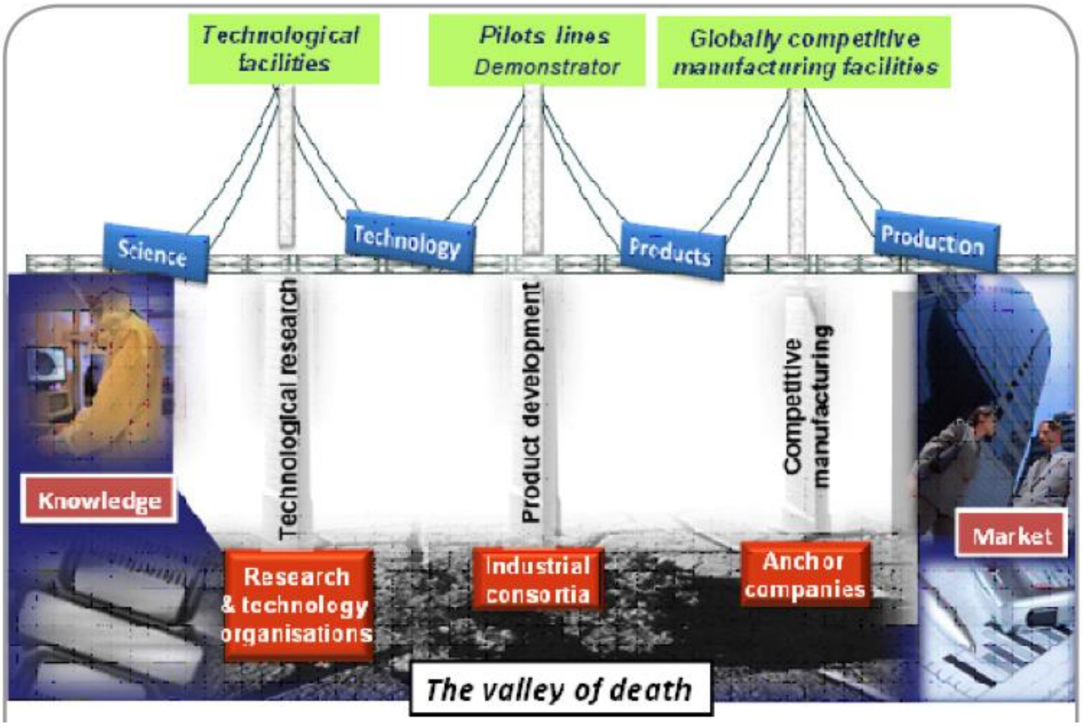

Figure 6: The Valley of Death according to High-level expert group (2011, p. 26) on key-enabling technologies

To sum up: the Valley of Death is placed at different places by different authors. To make the definition of the Valley of Death used in this research clear, the definition of technology development stages used by the OECD (2002) is used. Three stages of research and development are defined:

- Stage 1: Basic research
  - Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- Stage 2: Applied research
  - Original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
- Stage 3: Experimental Development
  - Systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D in other units.

Most of the literature set the valley between the end of applied research and the end of experimental development. This is roughly the same place as the High-level expert group (2011) place the product development pillar (second pillar in Figure 6). The position of the Valley of Death used in this research is visualized in Figure 7.

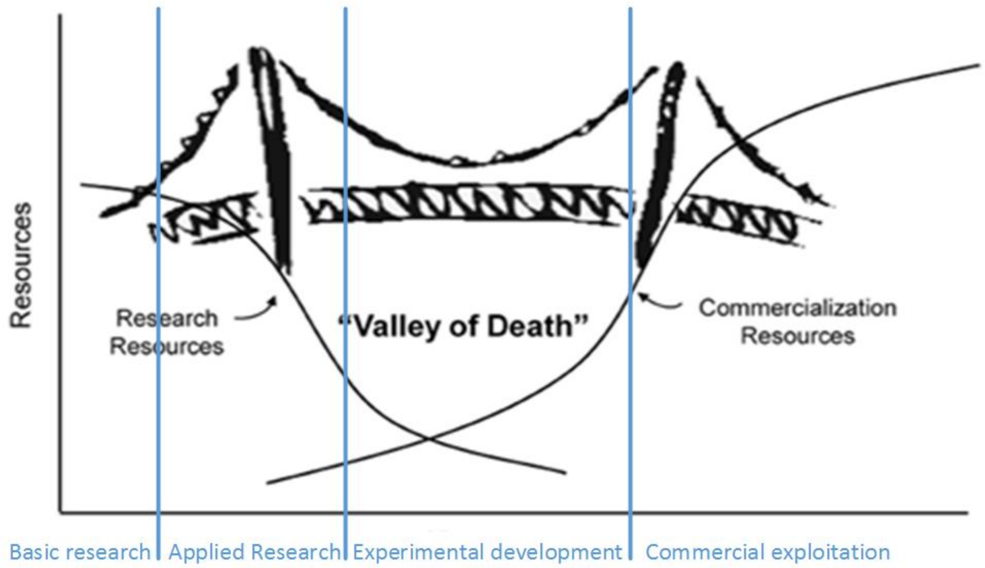

Figure 7: Valley of Death as defined for this research, visuals adapted from Barr et al. (2009, p. 371)

2.3.2 Commercialization strategies

There are several ways in which technology can be commercialized. However already mentioned in the

Introduction the majority of research focuses on a single organization commercializing via a strategy. In this paragraph we briefly state which commercialization strategies exist and when they are used.

2.3.2.1 Technology licensing

The most common strategy of technology commercialization from research to industry is licensing the technology to the industry (Thursby & Thursby, 2011). Generally this happens through a technology transfer office, a department on a university responsible for licensing agreements with industrial partners (Macho-Stadler, Pérez-Castrillo, & Veugelers, 2007). The downside of this strategy is that the technology has to be mature enough to be interesting for the industry. This is where the Valley of Death of innovation spoken of in 2.3.1 exists: the phase in which the technology is not fully mature yet. In order to use this strategy, the technology needs further development. Firms can also license technology between each other for commercialization purposes (Arora & Ceccagnoli, 2006). Some companies rely on licensing patens for turnover (Arora & Ceccagnoli, 2006).

2.3.2.2 Academic spin-off

The definition of an academic spin off is "a new company based on the findings of members of a research group from academia" (Festel, 2013, p. 455) . These spin-offs are generally used for technology that still needs further development before it can be introduced into the market and are based on a high degree of tacit knowledge (Shane, 2004). One downside of academic spin-offs is that financing is rather hard to come by because of the generally early stage of development of the technology (Ndonzuau et al., 2002). Academic spin-offs are however effective in commercializing research that is too high of a risk for established companies or that has failed earlier commercialization attempts because of inventor involvement, the inventor has the knowledge to develop the technology further (Shane, 2004).

2.3.2.3 Corporate spin-off

For corporate spin off we use the definition by Parhankangas and Arenius (2003). They define a corporate spin-off as a new business based on research and development done within a (larger) parent firm. A common reason for this is the fact that the discovered technology does not fit the strategy of the firm financing the research (Chesbrough, 2003a). The spin-off activity however, mostly occurs when the parent firm decides to restructure (Parhankangas & Arenius, 2003). A spin-off is chosen as the alternative over just closing operations on the research (Festel, 2013). A benefit of a corporate spin-off is that the parent company can support the start-up phase of the spin-off, this is generally harder for an academic spin-off (Festel, 2013).

2.3.2.4 Public procurement for innovation and Pre-commercial procurement

Public procurement for innovation (PPI) is a relatively new concept for funding innovation. Edquist (2009) defines this as a public organization that places an order for something that does not yet exist but must first be developed by the supplier. PPI ensures that the innovation supplier has the incentive and means to commercialize the innovation for the mass market (European Commission, 2014b). Pre-commercial procurement (PCP) is similar to PPI but in this construction further research is needed before commercialization. In this case a public organization acts as a buyer of new R&D (European Commission, 2014d). In FP7, PPI and PCP were not implemented as funding schemes, so it is unlikely to find information about this commercialization strategy in the projects. It seems however that this is a viable strategy to overcome the Valley of

Death. In the follow up of FP7, Horizon 2020, there is more focus on the demand side of research and innovation (European Commission, 2014b).

2.3.2.5 Corporate innovation market launch

The last strategy, however simple, is the launch of a developed innovation by a company. Partners in research and innovation projects can choose to internally bring products to market if it fits their market orientation.

The strategies used will be used in this research to see whether or not a strategy is dominant or better suited for commercialization of results in research and innovation projects.

2.3.3 Influence of consortium composition on commercialization

Currently in the literature there is little to be found on the influence of the research consortium on the commercialization of developed technology. We did discover one article by Hall, Link, and Scott (2003) on research into public private partnerships between university and industry funded by the US Advanced Technology Program. It should be noted that universities cannot be lead partners in research joint ventures funded by the US Advanced Technology Program. The research by Hall et al. (2003) focuses on the role of the university in research joint ventures and its influence on the efficiency of the research partnership and the development and commercialization of the technology. The findings in this article indicate that projects including universities as partner do not accelerate the time to commercialize the technology. The authors suggest that the reason of this is that universities are included in more difficult projects that have lower probability to be completed earlier. Another finding is that large projects or projects with large lead participants are also less likely to commercialize the technology faster. Projects with a non-profit or medium size organization as lead participant are expected to commercialize the technology earlier. For this research this can suggest that the lead partner is of influence on commercialization of project results.

In the evaluation of FP6 (Arnold, 2009) a characteristic is mentioned that might have an influence on commercialization of project results. The difference between participation of small and large companies is mentioned. Large companies use the projects to network more and profit from portfolio effects, while small companies are using the programmes for more short term outputs directly related to their product and process development, they do not have the resources for a portfolio approach.

2.3.4 Implications for the model

The topic of influence of consortium composition on commercialization is one of the most obvious knowledge gaps in literature. Very little is known about the influence of a research consortium on the commercialization of developed technology. As we already identified in earlier paragraphs of this chapter, most research attention goes to productivity in research projects, output in terms of patents, papers and other easier to quantify indicators. It is however clear that the aim of the public-private partnership structure introduced in FP7 is to stimulate commercialization of developed technology more than before its introduction (European Commission, 2013d).

The strategy used to commercialize technology will be added to the model in Figure 4 at the end of this chapter. It is likely that licensing of the technology is used in research and innovation projects when the technology is mature enough and the partners can agree on licensing agreements. An academic spin-off as commercialization mechanism is likely when the research project is dominated by research partners instead of industrial partners and when the technology is not yet developed enough for a private company to take the risk of commercializing the technology. A corporate spin-off is unlikely to be found in this research as it is expected that companies will not invest time, resources and effort in projects that do not align with their core business. It is however plausible that a technology seems promising at the start of project but in the end does not fit the core business. There are certain cases in which a corporate spin-off is possible. Public procurement for innovation and pre-commercial procurement are promising strategies to overcome the Valley of Death but were no funding options in FP7, they will be in Horizon 2020. An industrial partner launching the innovation on the market is a likely strategy to be found in this research. The PPPs introduced were specifically launched to strengthen the industry in these three areas (European Commission, 2013d).

This research will therefore focus mostly on the commercialization of technology and what are drivers and what are impediments for this. This research will also explore why a certain commercialization strategy is chosen and how successful this is or expected to be.

2.4 Theoretical concepts to describe context of the technology

This paragraph will be used to answer the following research sub-question: What theoretical concept help to explain differences in technological context?

In this section three theoretical concepts are explored for inclusion in this research. This theoretical concept has to help understand or explain differences in different technological fields if these are found in the analysis. Therefore the concept should be of an appropriate scope which can describe context between different technologies. The three concepts explored are Technological Innovation Systems, the Cyclic Innovation Model and the Triple Helix model. At the end of this chapter one concept is chosen that is best suited to evaluate any differences between two fields of developing technology.

The requirements of the concept are that it needs to be able to describe the context in which a certain technology is imbedded. This is the main requirement as different contexts can be of influence on the commercialization of project results. Another requirement is that it needs to be able to compare different technological fields. This is a requirement because it helps explain differences when these are found in different technological fields. The last is that the concept describing context should be of a static nature. This is needed as this project researches projects, which are limited in time by definition. It is assumed that the context is not likely to change much during a project.

2.4.1 Technological systems of innovation

The first theoretical concept is the systems of innovation approach. Recent literature focuses on two perspectives within this strand of research. The first is National innovation system approach and the second is the technological innovation system approach. The difference between these two approaches is the boundary of the system. In the national system of innovation approach this lies at the geographical border of a country while in the technological innovation system the technology is the boundary. This can traverse national boundaries. In this research we focus on an international system in two specific technological fields. Therefore only the technological innovation system approach will be explored for this research.

The definition of a technological system of innovation is “a network of agents interacting in the economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology” (Carlsson & Stankiewicz, 1991). In the technological innovation approach two aspects are captured, the structural characteristics and dynamics. The structural parts are defined as actors, networks and institutions (Bergek et al., 2008). The dynamics of the system are described as functions of innovation systems (Hekkert et al., 2007). The structural components are described in 2.4.1.1 and the functions in 2.4.1.2.

2.4.1.1 Structural components of technological innovation systems

The first components of a technological innovation system are the **actors**. Many different actors can be part of the innovation system. The actors do not necessarily share the same common goal and conflicts between them are part of the innovation system. Not only actors in the value chain of a technology, universities and research institutes are considered as actors, but also actors like public bodies, interest organizations and venture capitalists are considered as actors (Bergek et al., 2008).

The second component of a technological innovation system are the **networks**. These networks can be formal but they can also be informal (Bergek et al., 2008). Some are set up to solve a specific task, such as standardization networks, others are grown more naturally, an example of this would be buyer-seller relationships (Bergek et al., 2008). Networks are an organizational form between hierarchies and markets, with as their essential function the exchange of information. Networks are mostly used when the resource exchanged involves complex information or know-how (Carlsson & Stankiewicz, 1991).

The third component of technological innovation systems are the **institutions.** There are formal as well as informal institutions, with the formal institutions being the rules that are codified and enforced such as government laws and contracts while informal institutions are considered tacit and shaped by interactions of actors. Informal institutions are for example norms or values of actors (Suurs, 2009). Institutions are an important part of technological innovation systems as institutions might need to be changed for a new technology (Bergek et al., 2008).

2.4.1.2 Functions of technological innovation systems

Function 1: Entrepreneurial activities

The role of the entrepreneur is important in a technological innovation system. The role of an entrepreneur is "to turn the potential of new knowledge, networks, and markets into concrete actions to generate–and take advantage of–new business opportunities. Entrepreneurs can be either new entrants that have the vision of business opportunities in new markets, or incumbent companies who diversify their business strategy to take advantage of new developments" (Hekkert et al., 2007, p. 421). Entrepreneurs are necessary in an innovation system to cope with uncertainties that come with new combinations of knowledge, technology, applications and markets (Hekkert et al., 2007).

Function 2: Knowledge development

A very important resource in modern economy is knowledge. R&D and knowledge development are therefore very important within the innovation system (Hekkert et al., 2007). This function involves all learning activities where the two most important ones are learning-by-searching and learning-by-doing. The first relates to basic science and the second relates to learning in a practical context, such as lab experiments (Suurs, 2009).

Function 3: Knowledge diffusion through networks

As already mentioned in 2.4.1.1 the essential function of a network is the exchange of information. This is especially important in a context where research meets government, competitors and market (Hekkert et al., 2007). According to Suurs (2009) it is important that policy makers communicate with technology developers and technology developers with scientists so a common understanding evolves between these actors. This makes it more likely that institutions can be aligned with the technology and vice-versa.

Function 4: Guidance of the search

The guidance of the search function is important because resources are always limited (Hekkert et al., 2007). The second function: knowledge development ensures that a variety of technologies exist. The search function ensures that resources are allocated to the technologies that are chosen for further development. This function therefore refer to the activities that positively or affect the visibility and clarity of the specific needs and wants of technology users (Hekkert et al., 2007). This can for example be in the form of policy directives.

Function 5: Market formation

When new technology emerges it cannot always compete with incumbent technology (Suurs, 2009). This can be because the invention is still inefficient when it is first recognized. The technology is not yet optimized and therefore may not offer any advantages over existing technologies (Hekkert et al., 2007). This may hinder the diffusion of the new technology. The role of this function is to perform activities that contribute to the creation of demand by, for example, stimulating the use of the new technology or by taxing the incumbent technology (Suurs, 2009).

Function 6: Resource mobilization

Both financial resources and human capital are necessary as input to all activities within an innovation system, these resources are necessary to make knowledge production possible (Hekkert et al., 2007). Funds made available for R&D on specific technological knowledge by, for example, industry or governments are an example of an activity in this function.

Function 7: Creation of legitimacy

For a technology to develop well it has to be part of or to overthrow the incumbent regime (Hekkert et al., 2007). Actors that have vested interests will oppose to the development of the new technology. On the opposite side, coalitions can emerge that function as a catalyst by putting the technology on the agenda and by lobbying for resources or favourable policy schemes (Hekkert et al., 2007).

As already becomes clear from the paragraphs above, the functions are not independent but influence each other. Hekkert et al. (2007) describe virtuous and vicious cycles which are visualized in Figure 8. Cycle A is a cycle in which entrepreneurs lobby for market formation, since there is no level playing field. Cycle B is where entrepreneurs lobby for better economic conditions in the form of resources to perform R&D and Cycle C is where, for example, a government sets a limit on carbon emissions, in order to stimulate knowledge development in technologies that do not have these emissions (Hekkert et al., 2007). A vicious cycle can be triggered by technology not meeting the expectations, therefore reducing the entrepreneurial activities, which in turn lower the activities in all other functions of a technological innovation system (Hekkert et al., 2007).

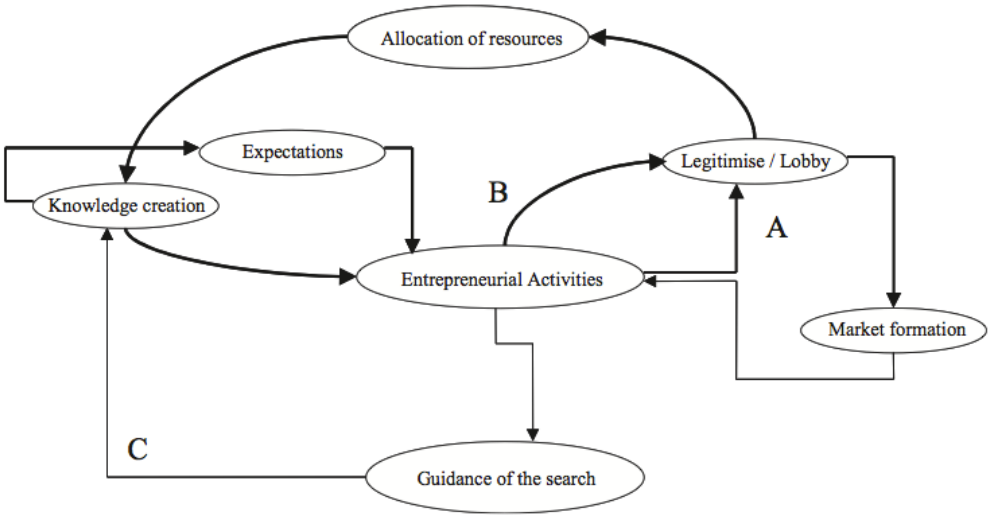

Figure 8: Motors of change (Hekkert et al., 2007, p. 426)

2.4.2 Cyclic innovation model

The cyclic innovation model is a recent model by Berkhout, Hartmann, Van Der Duin, and Ortt (2006). This model captures the iterative nature of processes in innovation networks. It is based on the dynamics in technological development and dynamics in market transitions. The technological research cycle is visualized in Figure 9.

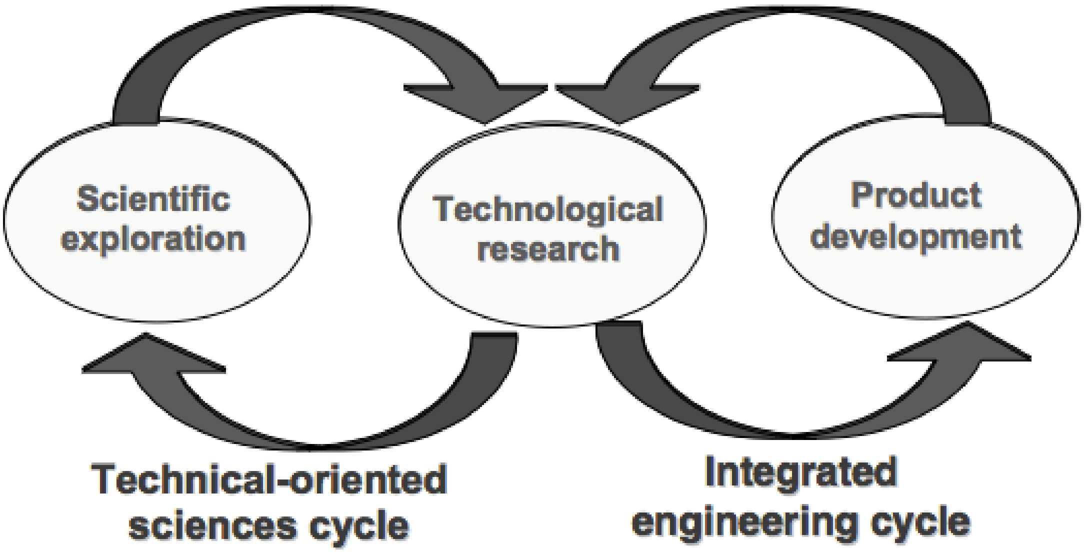

Figure 9: CIM: Technological research dynamics (Berkhout et al., 2006, p. 395)

In the technological research cycle, on the left is the technical-oriented sciences cycle. Here, technological research requires a wide-range of disciplines from hard sciences (Berkhout et al., 2006). Similarly, on the right hand side, the development of new products takes place. Modern product development is a multi-technology activity, that requires a many-to-one relationship like the technical-oriented sciences cycle. Therefore many different skills are needed to successfully innovate (Berkhout et al., 2006). Technological research can have two triggers as shown in Figure 9. It can have a science push, where technological research is triggered by new scientific insights (the left side of Figure 9). The other trigger is called function pull, where new functional requirements are driving technological research (the right side of Figure 9) (Berkhout et al., 2006).

The other part of the model is based on market transitions. Here human and societal needs play a central role, rather than technology. A visualization can be found in Figure 10.

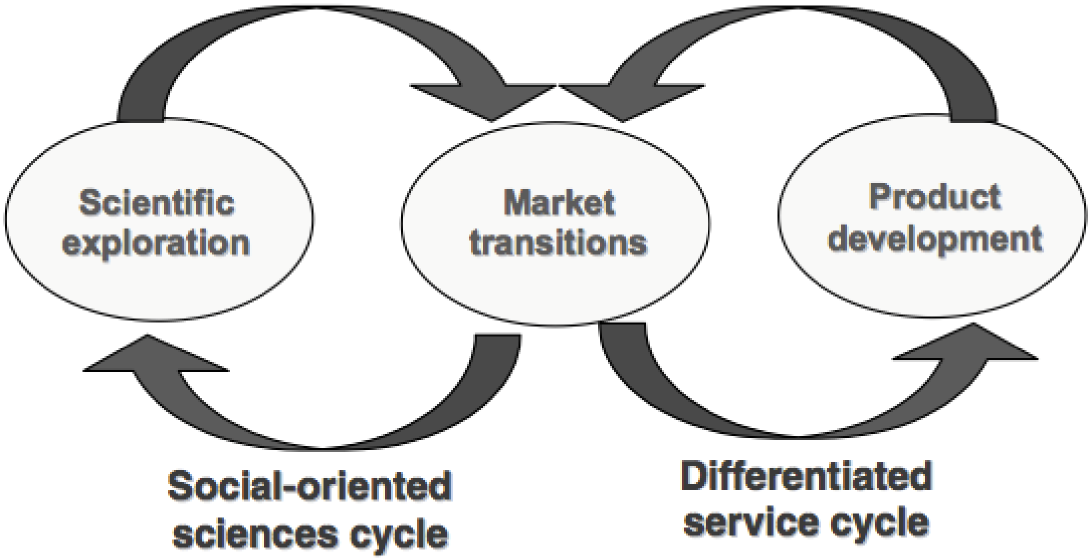

Figure 10: CIM: Market transition dynamics (Berkhout et al., 2006, p. 396)

On the left side is the social-oriented sciences cycle, where the cyclical interaction in socioeconomic development takes place. In this cycle new insights regarding emerging and receding economic trends take place. This requires again a wide variety of disciplines, but this time in soft sciences (Berkhout et al., 2006). New socio-technological developments can be put on the market faster with less risk due to these insights (Berkhout et al., 2006). On the right side the cyclical process to serve a changing society with new product-service combinations takes place. Here early users play an important role in making the process successful, using the customers creativity (Berkhout et al., 2006). Here too are two triggers. On the left side, demand for a new product-service combination based on societies needs and concerns are the drivers. On the right side the market transition is triggered by the innovate capacity of the business community, this is the driver on the supply side (Berkhout et al., 2006).

Comparing both models shows the dual nature of scientific exploration and product development, science has a hard, technical side and a soft, social side and the same is true with product development (Berkhout et al., 2006). The essence of the Cyclic Innovation Model is that both aspects are essential for innovation and should be integrated (Berkhout et al., 2006). A visualization of the full model can be found in Figure 11. As can be seen in this figure, entrepreneurship is at the centre, because (Berkhout et al., 2006) state that "without entrepreneurship there is no innovation" (Berkhout et al., 2006, p. 397). CIM views innovation processes as continuous interactions between both development and changes in four areas, Markets, Product and Services, Technology and Science (Van Der Duin, Ortt, & Kok, 2007).

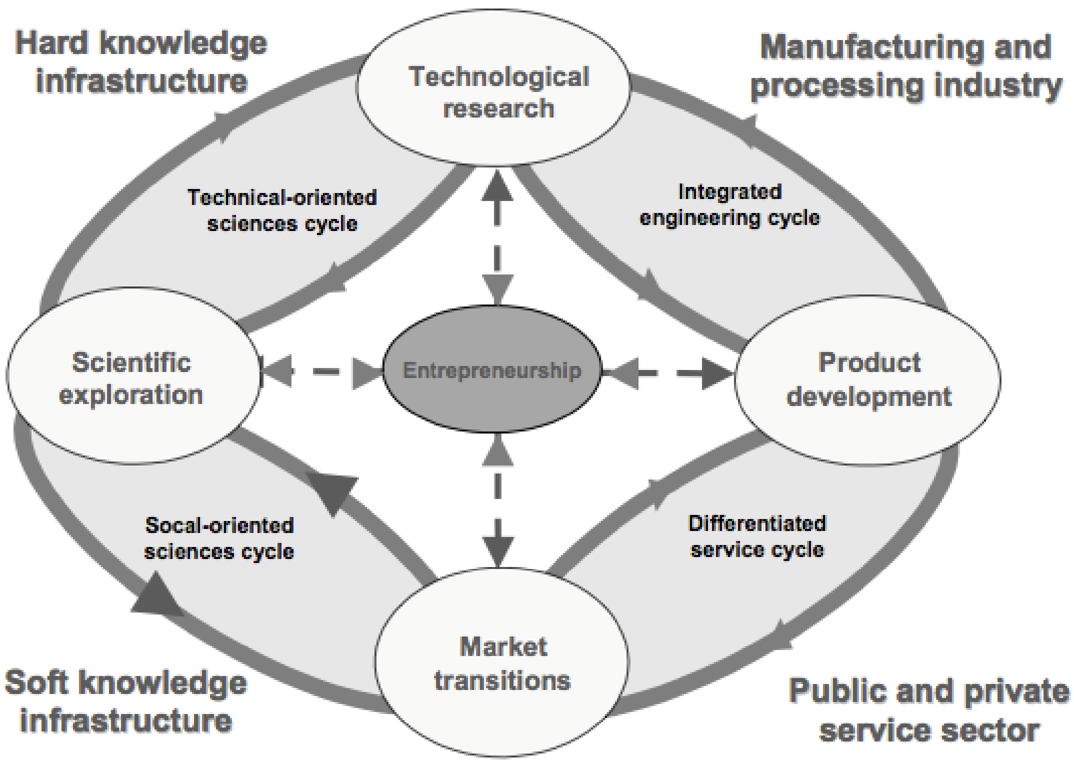

Figure 11: Complete cyclic Innovation model (Berkhout et al., 2006, p. 397)

2.4.3 Triple Helix

The triple helix concept is one where the interactions and collaboration between three parties is central. These three parties are governments, industries and universities (Etzkowitz & Leydesdorff, 2000). Each of these parties traditionally have their own role but in the triple helix model it is assumed that overlap and interfaces between these three parties are needed to successfully innovate (Etzkowitz & Leydesdorff, 2000). At the interfaces organizations exist that facilitate interaction (Etzkowitz & Leydesdorff, 2000), an example of this is the technology transfer office between university and industry as described in 2.2.2. The thesis for a triple helix structure is that the potential for innovation and economic development in a knowledge economy lies in a partnership between knowledge institutions with industry and governments (Etzkowitz & Leydesdorff, 2000). A visualization of the model proposed by Etzkowitz and Leydesdorff (2000) can be found in Figure 11

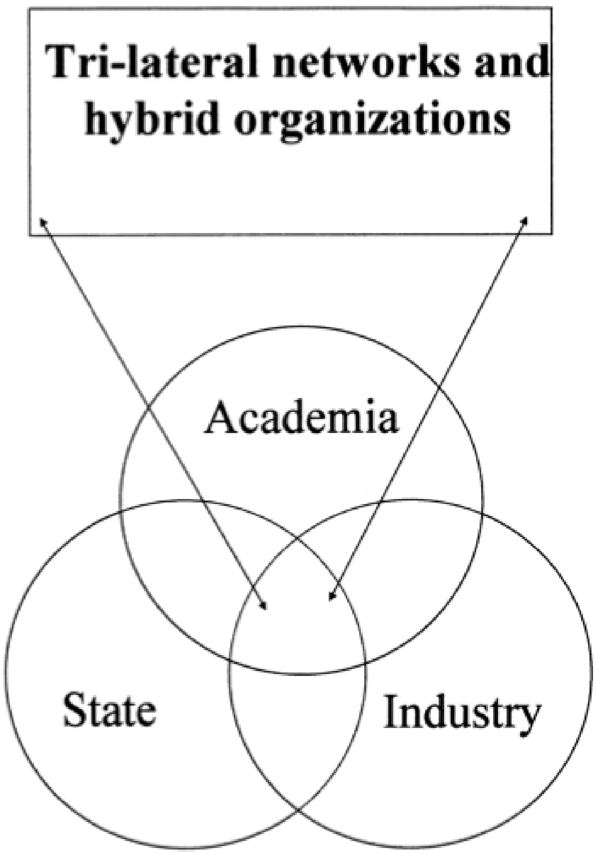

Figure 12: Triple helix model (Etzkowitz & Leydesdorff, 2000, p. 111)

2.4.4 Choice of concept

For this research a concept is needed to help understand differences of the technological context in this research. This implies that a difference between two technological fields should be accommodated by the concept. One of the assumptions that is made in this research is that the innovation infrastructure of that technology must be performing well in order to successfully commercialize the technology. Another requirement of the model is that it needs to support one iteration or step in the innovation process. The unit of research is a consortium specifically set up to perform a research project, which does not necessarily continues collaboration after the project.

Before a model is selected to be used, the similarities are explored. All models focus on actors and how they interact with each other. As this is one of the important influences in innovation, most notably between university and industry. Both the Innovation System approach and the Cyclic Innovation Model note the importance of entrepreneurship. In the cyclic innovation model this is even at the core.

The Cyclic innovation model is actor-based where single organizations are somewhere positioned in the model. One of the assumptions in this model is that to successfully innovate parties on different positions in the model are needed, covering the entire innovation arena. This model can be used to evaluate the consortia where in the model there is an actor or partner missing, which very well could stimulate or hinder innovation. But the scope of this research is broader. The model can be used to compare consortia with each other, but it is unable to explicitly distinct technological contexts. The cyclic innovation assumes that innovations build on innovations. This model would therefore be more suitable for a research that also includes case studies of projects prior to and after the projects included in this research. The model is useful for describing interaction and phases in innovation.

The triple helix model is also not suitable to describe the technological context; it focuses more on the collaboration and roles of different parties. The scale of this model is of a too high level to be used in this research. Triple helix is a concept that, when implemented correctly, can stimulate economic growth in a knowledge society. It however does not show differences between different technological areas. This model focuses mainly on collaboration

The technological system of innovation approach is suitable for this research. It is specifically set up so it can explore the innovation system and compare them for different technological contexts. This is a requirement for a concept that describes technological context. Another requirement is that the concept needs support for a single iteration of the technology, this requirement is also met. A technological innovation system is assumed not to change during the course of a research project. This makes the technological innovation system approach the most suitable approach for this research.

	CIM	**TSI**	**TH**
Supports different technological fields	x	x	
Scope is suitable for describing context	x	x	
Model describes a static context at a point in time		x	x

2.5 Conclusion and implications for conceptual model

At the start of this chapter we presented a basic conceptual model. With the insights from literature it becomes more substantial and gives some direction into what factors are possibly having an influence on commercialization. In 2.2 factors that explain consortium performance were explored, these are visualized in Figure 13 in the left part. In 2.3 commercialization of research results were explored. Here we didn't find any influences on commercialization of technologies *by consortia* however we did find some indicators what strategy could be used to commercialize project results; this is visualized in the bottom part. In 2.4 theoretical frameworks were explored that can be used to explain differences between the two areas if found in the analysis of the data. Here the technological innovation system approach is chosen, because above all it assumes a single point in time and not a dynamic system, it helps with the right part of the system. All these findings are used to elaborate the conceptual model, which is visualized in **Figure 13**. The missing links are in the middle: How will a consortium commercialize technology and what characteristics are of influence? Data needs to be collected in order to gain this knowledge. In the chapter 1 the data collected will be described.

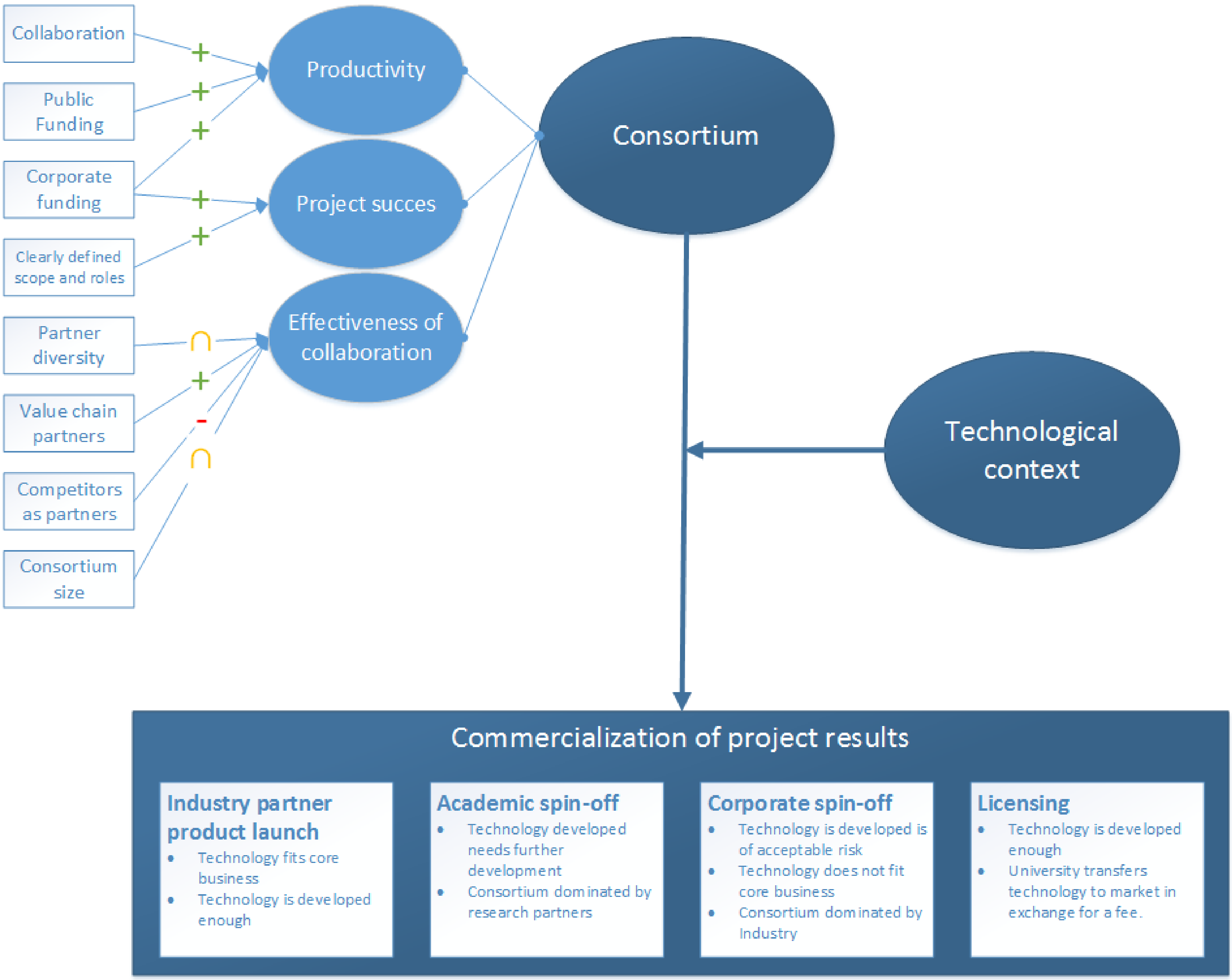

Figure 13: All findings of the literature visualized, used as starting point for the conceptual model deliverable of this study

3 Empirical data

The purpose of this chapter is to describe how the data is collected to answer the following research questions. The conceptual model in Figure 13 at the end of chapter 2 is being tested with empirical data:

- Which commercialization activities and strategies are used in European research and innovation projects?
- What consortium characteristics affected the commercialization activities?
- What is the influence of the technological context on commercialization of research results in research and innovation projects?

In this chapter the empirical data collected for the research will be described. First the sources of data collected are described in 3.1. Secondly the method of sampling the projects for the case-studies will be described in 3.2. In this paragraph also the results of the sampling and any changes made will be described. In 3.3 the selection of the case-studies in this sample on which this research will be based is described with the motivation of choice. In 3.4 the data collected for each case-study will be described. And in 3.5 the methodology for analysis will be described.

3.1 Sources

For each project the following sources were available:

- Grant agreement with technical annex, that gives information about:
  - The goals and objective of the project.
  - The expected outputs
  - The expected impact
  - The planning
  - The partners involved, including the coordinating partner and
  - How the money is divided among the partners.
- Review report or Assessment report (not available for all projects, as some projects have not been not reviewed yet). This is a document of the European commission giving information on the performance of the project. It gives information on:
  - The progress of the project, whether or not the goals and objectives are met;
  - Whether or not the resources are utilized correctly;
  - Whether or not project management was successful, partners collaborated and integrated the work correctly, and whether or not partners are under performing;
  - What the potential for commercialization is and whether or not this also has impact on SME's involved in the project.
- Project website, every FP7 project is required to have a website.
  - The websites were explored to find any useful data for the research
- Interviews
  - 2-3 interviews per project with project members
  - One interview is always with the project coordinator, because the coordinator has the most complete information.
  - One interview is with a research partner such as an University or Research institute;
  - One interview is with a private/industrial partner such as an SME or large enterprise;
  - This is done to get a diverse and complete picture of each project.

These sources are combined into a case-study for each project. The format used for this is the case-study template (Appendix D) provided by Technopolis-group which is used for evaluation of the FP7-NMP programme. Technopolis-group provided access to these data. The data will not be made publicly available as these are confidential. The results of the analysis will be described anonymously in chapter 4.

3.2 Sampling

The data used in this research is part of the evaluation of the FP7-NMP programme. A sample of all projects is performed. In this paragraph we describe the methodology of the sampling.

3.2.1 Mapping project diversity

The FP7-NMP programme funded 799 projects, including the PPPs. The main objective of the sampling was to select projects that capture the full variety of the FP7-NMP programme. There are three dimensions that show the diversity of projects: the themes, the funding sub-schemes and the technology readiness level.

- **The themes of the FP7-NMP projects:**
    - Nanotechnologies and nanosciences
        - Projects in this theme focus on “studying phenomena and manipulation of matter at the nanoscale and developing nanotechnologies leading to the manufacturing of new products and services” (European Commission, 2013e).
    - Materials
        - Projects in this theme focus on “using the knowledge of nanotechnologies and biotechnologies for new products and processes” (European Commission, 2013e).
    - New production processes
        - Projects in this theme focus on “creating conditions for continuous innovation and for developing generic production 'assets' (technologies, organisation and production facilities as well as human resources), while meeting safety and environmental requirements” (European Commission, 2013e).
    - Integration
        - Projects in this theme focus on “Integration of technologies for industrial applications. Focusing on new technologies, materials and applications to address the needs identified by the different European Technology Platforms. (European Commission, 2013e)”
    - PPP Energy Efficient Buildings
        - Projects funded in this theme focus on “research and innovation to reduce the energy consumption and CO_2 emissions related to new and retrofitted buildings and districts across Europe” (European Commission, 2013d).
    - PPP Factories of the future
        - Projects funded in this theme focus on “the development of enabling technologies and to foster innovation in the EU manufacturing sector, with a particular emphasis on SMEs. Its focus is on restoring growth and achieving sustainability, which requires boosting competitiveness and a strategic shift in Europe from cost-based competition to an approach based on the creation of higher added value” (European Commission, 2013d).
    - PPP Green cars

        - Projects funded in this theme focus on the improvement of the "sustainability of all European road transport and accelerate the electrification of road and urban transport, a potential new market opportunity. Since European automobile producers must compete globally" (European Commission, 2013d).
- **Funding sub-schemes (Technopolis-group, 2014)**
    - CP: Collaborative project, generic
        - The goal of collaborative projects is research aiming at developing new knowledge, new technology, products, demonstration activities or common resources for research.
    - CP-FP: Small or medium-scale focused research project
        - Focussed projects focus on a research and technological development activity and/or a demonstration activity. These projects target a specific objective and have a limited scope
    - CP-FP-SICA: Small or medium-scale focused research project for specific cooperation action dedication to international cooperation partner countries
        - Is the same as a normal focussed project, but include partners from non-EU countries.
    - CP-IP: Large-scale integrating project
        - Are ambitious objective driven research with a 'programme approach'
        - Activities may include: research and technology development, demonstration, technology transfer, training, dissemination, knowledge management and exploitation, consortium management and other activities.
    - CP-TP: Collaborative project targeted at a special group (such as SMEs)
        - Have the same goal as generic collaborative project but are targeted at participation of a specific group.
    - CSA-CA: Coordinating action (*Not used, not technology based)*
    - CSA-ERA-Plus: ERANETplus (*Not used, not technology based)*
    - CSA-SA: Supporting action *(Not used, not technology based)*
- **Technology readiness level (TRL)**
    - There are 9 different levels of technology readiness which corresponds with the state of development of the technology at the start of the project (European Commission, 2014e).
        - TRL1: Basic principles observed
        - TRL2: Technology concept formulated
        - TRL3: Experimental proof of concept
        - TRL4: Technology validated in lab environment
        - TRL5: Technology validated in relevant environment
        - TRL6: Technology demonstrated in relevant environment
        - TRL7: System protype demonstration in operational environment
        - TRL8: System complete and qualified
        - TRL9: Actual system proven in operation environment
    - For the purpose of the sampling the levels are aggregated to four levels as the samples of each level will be too small when 9 levels are used
    - Subsequently, the following levels are used (Technopolis-group, 2014):
        - TRL 1-2: Conceptual/basic research
        - TRL 3-4: Labwork
        - TRL 5-6: Application into field or industry (Piloting)
        - TRL 7+: Prototyping and scaling-up

3.2.2 Sampling strategy

The combination of theme and funding scheme are explored in Table 1. For each combination with more than 10 projects, 2 samples are drawn (green in the table) and for each combination of 4-10 projects, one sample is drawn (yellow in the table). For each subset the sample is taken for the TRL that occurs the most frequent. When two samples are drawn then the samples are of two different TRLs. One of the most frequent and one of the second most frequent. With this sampling strategy the most frequent combinations will be explored, which captures the variety of projects funded by FP7-NMP.

	EeB	FoF	GC	I	M	N	P	Other	Total Projects
CP	8	17	7		2			4	38
CP-FP	12	33	4	11	102	108	45	1	316
CP-FP-SICA					3				3
CP-IP	25	21	6	43	36	40	28	3	202
CP-SICA					7				7
CP-TP	6	30		43	14	18	18		129
CSA-CA	1			24	16	4	1		46
CSA-ERA-Plus					1	1		1	3
CSA-SA	2	1		31	1	20			55
Total	**54**	**102**	**17**	**152**	**182**	**191**	**92**	**9**	**799**

Table 1: Number of projects for each Funding-scheme/theme combination (green: 2 projects sampled, yellow: 1 project sampled)

3.2.3 Sampling results

The initial list of projects selected can be found in Appendix B. Some changes in the sample had to be made for the sample as some were not fit for a case-study. In 9 cases a new sample had to be drawn because the project had no project website or the project aims for a large conference that has yet to be held. In the sample there has been a check for country distribution of the coordinating party. The United Kingdom was over-sampled and Sweden was under sampled. This was the motivation to change the UK-led SANS project by the Sweden-led NANOMMUNE project, both projects have the same theme, funding-scheme and TRL. Some projects in the sample were also started very recently. In collaboration with the European Commission there was agreement that projects starting later than July 2013 will be removed. 7 projects have been replaced with older projects with the same theme, funding-scheme and TRL. In two cases this was not possible (NOVACAM and STREAMER) because alternative projects were also started recently (fall 2013). The commission also indicated that important chemistry projects were missing from the initial sample. A random sample of the chemistry projects was drawn and replaced another project in the sample. F^3 factory was sampled and replaced by the project Multilayer which had the same characteristics. When alternating the sample the country distribution was taken into account. The final sample can be found in Appendix C.

3.3 Selection

For this research 10 case-studies of the sample will be performed by the author of this thesis, 41 others will be done by other case study researchers for the purpose of the FP7-NMP evaluation. Because this research explores the commercialization of technology developed within innovation projects, these 10 projects should be of a high technology readiness level as this increases the chance that at the end of the project the technology is (nearly) ready to be commercialized. Furthermore the project should have industrial/private parties participating in the project, as they are more likely than public partners to commercialize results of the project. We decided that the new PPP structure is most fit for this research as it focuses on strengthening their respective industries, by introducing new technologies. In other words these projects focus on technologies that at the end of the project are expected to be ready to be commercialized. The nature of the public-private partnerships also ensures that the participants of the project are always a mix of public research and industrial partners. This is one of the areas this research focuses on.

When looking in the sample of the projects in the three PPP areas, it became obvious that the Green Cars PPP was not fit for the purpose of this research as the three sampled projects were of a low TRL (3-4) and focussed mostly on technologies for new types of batteries. The documentation provided for these projects showed that at the end of the project, the technology was probably not ready to be commercialized. The projects in the Energy-efficient buildings PPP and Factories of the Future PPP are more diverse in nature and of a higher TRL. Therefore randomly 5 EeB projects and 5 FoF projects from the sample were selected for our research project. In the table below is shown which projects we used for the case-studies.

EeB	E-Hub	Harwin	Nanocool	Easee	Streamer
FoF	Phocam	Harco	Hi-Micro	Eneplan	Fasion-able

3.4 Domain exploration

One of the aspects that is included in this research are differences between technological contexts. In the coming three paragraphs all information that is known about the technological areas “factories of the future” and “energy efficient buildings” is described. There is not much known yet about the technological context of these two areas, as the public private partnership structure was only launched recently in 2008 and projects are that have this structure are only just finishing (European Commission, 2013d).

3.4.1 Factories of the Future

The Factories of the Future PPP was launched to strengthen manufacturing in Europe. It comprises of 2 million enterprises employing 31 million in 2009 responsible for 80% of total EU exports (European Commission, 2013c). Manufacturing in Europe is for a large part provided by SMEs. According to the Commission they are responsible for 45% of the value added by manufacturing and 59% of manufacturing employment (European Commission, 2013c). The sector also has as a small number of companies that are larger compared to other sectors (Wengel & Shapira, 2004). Suffice to say, manufacturing is very important for the European Union. The European Commission expects that advances in science and innovation will help in expanding Europe’s manufacturing in new and traditional industries (European Commission, 2013c). Furthermore, according to the Commission, manufacturing is an R&D intensive activity (Wengel & Shapira, 2004) and is critical in the innovation chain as it enables technological innovations to be applied in products, goods and services (European Commission, 2013c). After the financial crisis occurred in Europe, R&D expenditure dropped because costs and risks involved were too high and feature a too long return on investment. Public support in this area was therefore needed (European Commission, 2013c). In the PPP Factories of the Future there is a particular emphasis on development of technologies by SMEs (European Commission, 2013d). The sector is also slowly integrating with all Member States, however there are still differences between them, for instance in productivity in machinery production (Wengel & Shapira, 2004). The FoF PPP ensures that this sector becomes more integrated.

Objectives in the factories of the future PPP according to the European Commission (2013c) are to increase competitiveness in manufacturing globally through research and innovations for the transfer to knowledge-based instead of capital-based production (Wengel & Shapira, 2004). To do this, research is based on modern production plants, automation of industry, and software for design and plant management. These developments are expected to be resource and energy-efficient. Specifically this means investments in new materials or products by for example 3D printing, adaptive manufacturing equipment, resource-efficient factory design, collaboration and customer-focused manufacturing (European Commission, 2013c). Manufacturing technology is required to enable other technologies such as nanotechnology to be transferred into marketable products or services, so the factories of the future are characterized as enabling technologies (European Commission, 2013c). An overview of the factories of the future PPP is found in Figure 14. In this figure the domains on which the PPP focuses are shown.

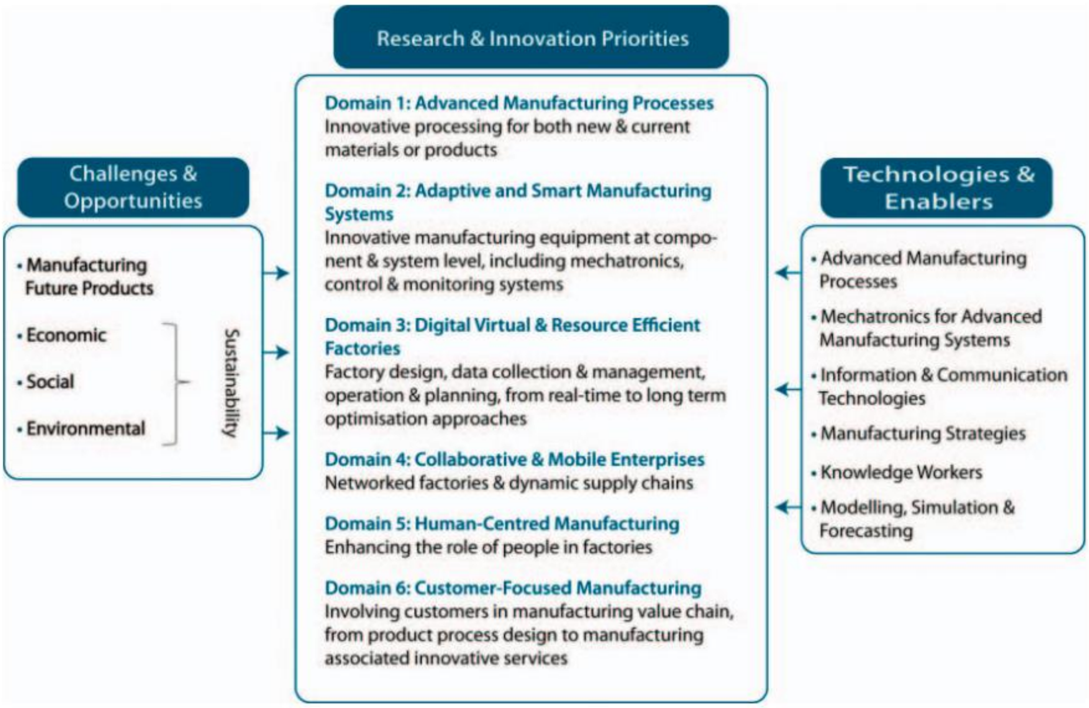

Figure 14: Factories of the future roadmap framework (European Commission, 2013c, p. 12)

3.4.2 Energy efficient buildings

The energy efficient buildings PPP focuses on technological innovations in the building industry, aiming to shift this to a high-tech industry. Construction is also one of the largest economic activities in Europe, this is what the PPP's have in common, they are all targeted at large industries that were hit by the economic downturn (European Commission, 2013d). The numbers of this industry support this. It's yearly turnover is at least 1.2 *trillion* euro, this includes the construction industry and the value chain, it is responsible for 9,6% of the European GDP and is the biggest industrial employer (European Commission, 2013b). The sector is driven largely by fragmented SMEs, in fact 95% of the industrial players in this area are SMEs. These SMEs have yet to recover from the financial and economic crisis (European Commission, 2013b). The SMEs also don't have the budget and willingness to undertake innovation activities (Blayse & Manley, 2004). Reason for this are the most common procurement methods, mainly the lump-sum contract (Blayse & Manley, 2004). These procurement methods usually put the risk at the supplier. The supplier in turn doesn't want to take the risk. The PPP structure aims to strengthen the industry by performing multidisciplinary research in this sector, by creating a critical mass that industry itself cannot provide, creating innovative value chains and by increasing the synergy between research and development in this area (European Commission, 2013b).

As the name of this PPP already gives away there is a big focus on sustainability. Currently buildings in the EU use 40% of the total energy and are responsible for 36% of the greenhouse gas emissions (European Commission, 2013b). The goal of this PPP is to support research and innovation related to new and retrofitted buildings and districts that help reduce these numbers (European Commission, 2013d). Three main challenges are addressed in this PPP (European Commission, 2013d):

- Renovation of existing building stock
- Positive energy buildings
- Energy efficient districts

The PPP shows strong commitment from the industry, implying that there is a strong demand for collaboration in the value chain and collaboration with SMEs (European Commission, 2013d). This is characterized by strong public involvement. 10% of the contribution in this PPP goes to public bodies, compared to the 0.1% in Factories of the Future, this can be explained by the fact that many projects use demonstrators in districts and neighbourhoods owned by a public body (European Commission, 2013d). Public involvement is also large with the adoption of government regulations and standards that hinder innovation in this sector (Blayse & Manley, 2004).

In the construction sector clients are one of the main drivers of innovation they can demand requirements of the supplier (Blayse & Manley, 2004). In the construction sector there is also a preference to proven technologies, as buildings need to be durable (Blayse & Manley, 2004).

3.4.3 Main differences between FoF and EeB

From the paragraphs above the following differences are clear from the descriptions given by the EC. These are placed in Table 2 below. In the analysis it will become clear if differences in consortium design are related to differences in the technological fields. For example it is plausible that the inclusion of public bodies is an enabler for energy-efficient building technology commercialization but not necessarily for factories of the future technology.

	Factories of the future	Energy efficient buildings
Program focus	Knowledge-based manufacturing technologies	Sustainable building/district technologies
Structural components of innovation systems		
Actors	Mixed Large and Small-medium enterprises, little public involvement	Mainly Small-medium enterprises, large public involvement
Networks	Well connected	Fragmented
Institutions	Health and safety regulations.	Highly regulated, standardized
Functions of innovation systems		
Entrepreneurial activities	Highly innovative	Low innovative capacity
Knowledge development	High R&D activity	Low R&D activity
Knowledge diffusion through networks	Represented by industrial group in the PPP	Represented by industrial group in the PPP
Guidance of the search	Steered by industrial group in the PPP	Steered by the industrial group in the PPP
Market Formation	No specific enabling institutions	Regulations stimulating energy-efficient technology
Resource Mobilization	PPP funding	PPP funding
Creation of legitimacy	PPP structure supported by industry	PPP structure supported by industry

Table 2: Main differences between FoF and EeB

3.5 Description of case study template

The data collected will be put into a case-study template provided by Technopolis-group, this template can be found in Appendix C. In this paragraph the data collected will be discussed.

1. Basis characteristics of the project

Here the most important characteristics will be described for each project, which includes:

- The coordinator of the project, the type of organisation the coordinator is connected to and in which country the coordinator resides;
- This is also done for each of the partners;
- The number of partners is described here;
- The theme, funding-scheme and TRL at the start of the project;
- The budget of the project and the contribution by the EC and,
- A summary of the project.

These are easily to influence characteristics for the European Commission. These can be used to influence projects to commercialize if they analysis shows that they are of influence. Information on size, scope and technology maturity is collected here. Basic characteristics for the conceptual model are collected in this part.

2. Objectives and challenges addressed by the project

In this part the objectives of the project are described. This is done for the overall project and for the different work packages within the project. Furthermore the economic, industrial and societal challenges that are addressed are described here. In the interviews we asked which objectives were deemed the most important from the perspective of the interviewed organisation. Furthermore in this part the interviewees were asked for the motivation for participation in the project. For the conceptual model in this information on the success of the project is collected and information which objectives and in which areas these objectives are achieved or not.

3. Output

In this part of the case study the output of the project is researched. Most output can be found in the documentation provided by the EC. In order to identify the most important output, the interviews are used. The interviewees are asked what the most important output of the project is according to them. For this part we also ask the interviewees whether the project over- or underachieves in delivering output and what the most important barriers and enablers were in delivering output. This is the first information that is collected on potential commercialization. Patents can be of influence but also specific technology which can be commercialized. Barriers and enablers for output can also indicate what specific reasons for project failure or success are.

4. Scientific and technological impact

In this part the scientific and technological impact of the project will be researched. Examples of this can be contributions to research infrastructures, standards, scientific breakthroughs or other projects launched that are based on this project. Here the interviewees are also asked what the most important S&T impact is (or will be) and what the barriers and enablers are to achieve this impact. The barriers and enablers might identify why certain output will be commercialized and why not. Here information is gathered on the technological context. What the influence is on the specific scientific and technological area related to the project. Here also is asked what the barriers and enablers are to find whether or not differences between technological contexts exist.

5. Economic impact

This part of the case-study is important for this research as it links directly to commercialization of the technology. Here is investigated what products/services or processes are substantially improved, what the impact is on the value chains, whether or not new firms are launched etc. Here the interviewees are also asked what the most important economic impact is from their point of view and what the barriers and enablers are for economic impact. In this part of the case study we also ask the interviewees what the consortium did to disseminate the results of the project to a larger group of companies, and whether or not this leads or led to economic impact. For the conceptual model this gives information on the commercialization of project results

6. Societal impact

In this part of the case-study the impact on a societal level is investigated. Examples of impact on this level are development of energy efficient products, processes or services, tools for sustainable development or health innovation. This part of the case-study is less important for the purpose of this study but is an important theme for the EC in the evaluation of the programme, that is why it is included. For this type of impact the interviewees are also asked what the most important societal impact is from their point of view, what the main barriers and enablers are in achieving this and what they did to disseminate results to a group of stakeholders and what the societal impact is of this.

7. Social networks and European Research area

In this part of the case study the collaboration and formation of the consortium is investigated. This part is mainly based on interviews. The interviewees are asked to indicate the initiator of the project and whether or not this is a follow up project. The interviewees are also asked to point out new collaborations between partners which they did not work with before and whether or not these new collaborations are fruitful. Furthermore in this part we asked the interviewees which partners are the most important for the commercialization of the project results. Lastly in this part the interviewees are asked how the project functioned in terms of collaboration, this can help identify project management issues. Interactions with partners is one of the influences identified in the literature review, information on this is collected here, along with more information on project formation and participant interactions.

8. European added value

This part of the case-study is less important for this research but could give some important insights what works and what doesn't work in projects. In this part we ask interviewees about synergy with national or corporate R&I programmes, for which part of the project the European funding was most crucial and what gaps the European funding fills that national/regional programmes leave open. The interviewees are also asked to specify how the European funding helps the project. For example international collaboration was needed, or whether it reduced the risk of the project significantly.

9. Administrative procedures

In this part the administrative procedures of the FP7 programme are evaluated, these are important for the FP7-NMP evaluation but not for the purpose of this research.

10. Open questions

In the last part of the case study the interviewees are asked whether they missed a question that they feel is important for the evaluation of the programme. Here we also ask the interviewees their main recommendation for Horizon 2020. These questions can identify best practices for the programme. It depends on the answer to this question how relevant it is for this research.

3.6 Analysis plan

In this paragraph the plan of analysis is described. This paragraph's purpose is to illustrate how the analysis is performed and why the analysis is structured in the way it is.

3.6.1 Step 1: Gather all information from the case studies in one place

To analyse the collected data, excel is used. In excel variables are made corresponding with the main consortium characteristics from the template (such as 'number of partners' and 'financial contribution of partners'). Next the characteristics identified in the literature, which were included in the conceptual model, will be added as a variable. An example of this will be whether or not the partners cover the value chain of the researched subject in the project. When interesting new insights come forward from the cases, these will be added as a separate variable, this to see if new insights can be derived from these case studies. This method is used to have an overview to see what the influence is of certain variables on the consortium commercialisation activities. Once this is finished filters on the variables will be added, this makes it possible to sort projects on for example 'number of partners' or 'financial contribution'. Having this overview makes it easy to see which variables have a strong influence on commercialisation.

3.6.2 Step 2: Compare variables with commercialisation activities

In this step the variables found in literature and other variables that came forward from the cases will be analysed to see what the influence is on the consortiums commercial activities. Some variables will have a simple 'yes' or 'no' structure (i.e. value chain covered in consortium) while others may have an absolute value (i.e. number of partners). Each variable will be compared with the commercialisation activities and noted. In this step the technological context is also taken into account. It can occur that there is a difference between FoF and EeB projects. When this occurs, differences in innovation systems will be used to try to explain the differences between them.

3.6.3 Step 3: Elaborate on strong predicative variables

The variables which seem to have a strong predictive character on commercialisation activities will be researched more in depth. Was a variable really a strong contributor to the commercial exploitation or not? The interviews are used to see if project partners really saw the variable as a strong contributor or not. All these will be collected to see which variables really have a positive influence on commercial exploitation. At the end of this step the results of the analyses are ready.

3.6.4 Step 4: Verify results

A variable that is identified having a positive influence on commercialisation in the 10 case studies will be compared to other, comparable cases. For this we look in the 41 other case studies performed within the FP7-NMP evaluation by other case study researchers. When a variable is verified in the other cases it is accepted as a factor affecting commercialisation activities.

4 Analysis Results

This chapter describes the results of the analysis. This chapter will answer the research questions:

- Which commercialization activities and strategies are used in European research projects that fall under the PPP flag?
- What consortium characteristics affected the commercialization activities?
- What is the influence of the technological context on commercialization of research results in research and innovation projects?

This chapter is structured as follows: In 4.1 the collected data will be described. Each variable found will be described here. In 4.2 the results on the influence on commercialisation activities of variables identified in literature will be described. At the end of this paragraph new variables that are discovered are also described. In 4.3 variables that have a strong predictive character will be further elaborated upon and compared with qualitative information from the cases. At the end of this chapter variables that are accepted as having an influence on commercialisation activities are described, these variables still need validation In 4.4 the results will be verified using other case studies performed for the evaluation of FP7-NMP[1]. At the end of this chapter factors that have an influence on commercialisation activities will be described in 4.5.

4.1 Description of collected data

In this paragraph the empirical data that we collected in the excel database is described. Each variable is described and for each will be explained how they are measured. First we start with the description of the variables derived from literature. Second, the description of other variables found in the case studies are described.

4.1.1 Variables derived from literature

Literature shows that certain characteristics of innovation projects can be of influence on the project. The variables that were found are 'collaboration', 'public funding', 'corporate funding', 'clearly defined roles and scope', 'partner diversity', 'value chain partners', 'competitors as partners' and lastly 'consortium size'. As for the technological context, there are two themes researched within FP7-NMP, the Factories of the Future theme and the Energy Efficient buildings theme. In Table 3 the data collected on variables derived from literature is shown. In this table the variable found in literature is described, how it is operationalized the variable and a description of the distribution in the 10 cases.

[1] 7th framework programme, The nanosciences, nanotechnologies, materials & new production technologies theme

	Variables derived from literature	Operationalization	Description of data
Project charac-teristics	Collaboration	Partners > 1	This is the researched topic, all cases have multiple partners
	Public Funding	EC Contribution to the project	The EC contribution ranges from €2,5mln to €8,0mln. This ranges from 65% to 73% of total project budget
	Corporate funding	Partner contribution to the project	The partner contribution ranges from €1,2mln to €3.6mln. This ranges from 27% to 35% of total project budget.
	Clearly defined roles and scopes	Yes or No	7 projects – Yes 3 project – No
	Partner diversity	Number and percentage of Large enterprises (LE), Small medium enterprises (SME), Research institutes (RI), Higher education (HE) and other (such as end user associations)	LE – 0 to 7 partners, 0% to 39% SME – 3 to 8 partners, 22% to 57% RI – 0 to 5 partners, 0% to 28% HE – 0 to 4 partners, 0% to 36% Other – 0 to 5 partners, (0% to 36%)
	Value chain partners	Yes if the partners cover the value chain, No in other cases	All cases cover the value chain.
	Competitors as partners	No competitors, no problems, problems	8 projects had no competitors in the project, 2 projects had no problems with competitors
	Consortium Size	No. of partners	Ranging from 7 to 20 partners
Technological context	Theme	FoF or EeB	5 projects are FoF and 5 are EeB
	Technology readiness level (TRL)	At start of the project: 1-2, 3-4, 5-6, 7+	1-2 – 0 cases 3-4 – 3 Cases 5-6 – 6 cases 7+ - 1 case
Commercia-lization	Plan to commercialize	Yes or No	8 projects have plans to commercialize or have already

			commercialized project results
	Close to commercialization?	Yes or No	5 projects have developed technology that is (near) ready for market launch In the other 5 projects, the technology needs further development in the project or after the project.
	Available on the market?	Yes or No	1 project has made a project result available to the market
	Commercia-lization strategy	Company in consortium, Academic Corporate spin-off, Licensing or No commercialization	1 project uses a research spin-off, 5 projects use companies inside the consortium, 1 project uses both a research spin-off and a company in the consortium, 2 do not have plans to commercialize, and for 1 project this is unknown, this project is just started.

Table 3: Description of collected data on variables derived from literature

4.1.2 Variables derived from the cases

The cases studies also gave insight into potential relevant variables that might be of influence but were not derived from the literature review. They are added to the data analysis when in a single case this is mentioned as a positive influence on the project. The other 9 cases are then checked for this variable. In the analysis step it should become clear if there is a connection with commercial performance.

Main research topic	Variables derived from the cases	How operationalized	Description of data
Project characteristics	Coordinating partner *An industrial coordinator can focus more on commercialization*	LE, SME, RI or HE	LE – 2 cases SME – 1 case HE – 3 cases RI – 4 cases
		Research or Commercial party	Research – 7 cases Commercial – 3 cases
	Funding scheme *Gives insight into the type of project*	CP, CP-IP, CP-FP, CP-TP	CP – 3 cases CP-FP – 3 cases CP-IP – 3 cases CP-TP- 1 case
	Did the project achieve its	Yes, No, Partially	Yes – 6 cases Partially – 1 case

	objectives?		No – 2 cases Unknown – 1 case
	Good project management perceived?	Yes, No	Yes – 8 cases No – 2 cases
	Good collaboration perceived?	Yes, No	Yes – 6 cases No – 2 cases In 2 cases there were elements of both good and troublesome collaboration
	Large number of partners perceived as a problem?	Yes, No	Yes – 3 cases No – 5 cases In 2 cases there was no clear answer between interviewees
Commercialization	Received ESIC Services *Consulting services focussed on commercial exploitation of project results*	Yes, No	Yes – 8 cases, all of the interviewees perceived this as useful No – 2 cases
	Developed technology commercialized in parts? *Is the concept developed commercialized as a whole, or in parts?*	Multiple technologies commercialized by different organisations or a single organisation Single technology developed commercialized by different organisations (technology taken apart) or by a single organisation	Multiple tech, single organisation – 0 cases Multiple tech, multiple organisations – 2 cases Single tech, single organisation – 1 case Single tech, multiple organisations – 5 – cases No commercialization – 2 cases
	End user or end user association involved as project partner?	Yes, No	In 4 projects an end user or end user association was involved as partner of the project In the other 6 projects this was not the case.

Table 4: Description of collected data on additional variables derived from the cases

4.2 Analysis of variable on commercial performance

In this paragraph the research focuses on the variables from 4.1 in relation with commercialization activities. For each variable we checked its influence on the commercialization activities. In this exploratory research a lot of variables that might be of influence have been identified. This step filters variables that do not seem to have an influence on the commercialization of technology. This is done because the focus of this research is to find variables that have an influence on commercialization.

4.2.1 Variables derived from literature

Project characteristics

Project budget

There is no clear line on commercialization when looking at the EC contribution. The project that received the least amount was the only project that already commercialized project results. The amount of EC contribution does not seem to have an influence on the *plans* of commercialization. When looking at projects that are close to commercialization, the projects that have received *less* contribution are closer to commercialization. This is against the expectation derived from literature. When looking at the percentage of the total funding being the EC contribution there is no pattern to be found anymore.

The amount and percentage of partner contribution show the same pattern as the EC contribution. This is also against the expectations derived from literature. It could be possible that total project budget explains commercialization better. When checking for total project budget the projects that are closer to commercialization had smaller budgets than the remainder of the selected 10 cases. *Therefore total project budget will be further explored in 4.3.*

Clearly defined roles and scope

This seems like a very clear indicator for commercialization. 7 cases had clearly defined roles and scope. All plan to commercialize project results and 5 of them are close to commercialization. 1 project has already commercialized project results. Of the 3 projects that didn't have clearly defined roles and scope, 2 of them do not have plans to commercialize. The other project started only recently, but has troubles already with roles and scope. For them it is unknown whether or not they are going to commercialize project results. *This variable will be further researched in 4.3.*

Partner diversity

When looking at the percentage of commercial partners versus research partners, there seems to be no influence on the commercialization efforts of the consortia. The same is true when looking at the percentage of large enterprises, small medium enterprises, research institutes and higher education and other organisations in the project. An explanation of this can be that all projects include a diversity of partners. *This variable will not be further explored.*

Value chain partners

It's hard to say something about this variable because all 10 cases have partners that cover the value chain of the project. In many of the cases the inclusion of end users or suppliers is mentioned as having a positive influence on the project. *Therefore, this variable be further researched in in 4.3*

Competitors as partners

In 2 cases multiple companies were operating in the same sector. However these research and innovation projects are designed in such a way that no problems occurred. In one case multiple architectural firms were included. In one of the interviews it became clear that the collaboration went very smoothly because the architectural firms do not operate on the same *geographical* market. This made collaboration smoother. In the other case multiple technologies are developed. And while the competitors compete on the same market, arrangements were made that they will not be commercializing the same technology. In relation to commercialization there is no difference between the 2 cases that include competitors and those which do not. *Therefore this variable will not be further explored.*

Consortium size

Consortium size shows the same pattern as project budget, projects which include less partners are closer to commercialization than project with a larger number of partners This is not surprising as projects which include more partners are bigger in scope and therefore have more budget. *in 4.3 will be researched whether a small number of partners, a smaller project budget or smaller scope is of influence on commercialization.*

Technological context

Theme

Projects that plan to commercialize technology are equally divided between the two themes. But the projects that are *close* to commercialization are not. Only 1 project in the EeB theme is close to commercialization while 4 projects in the FoF theme are close to commercialization. It seems that technological context is of influence on commercialization of project results. *This will be further elaborated in 4.3.*

Technology readiness level

Of the three projects that have a TRL of 3-4, 2 are planning to commercialize projects results and only 1 is close to commercialization. Of the 6 projects with a TRL of 5-6 all plan to commercialize the project results and 4 of them are close. The project that has a TRL of 7+ has no plans to commercialize. This has to do with the technology that is developed, it is still not ready for commercial exploitation according to an interviewee. It seems pretty straightforward that technology that has a higher TRL is closer to commercialization. *This variable will be further rese arched in 4.3.*

Commercialization

Commercialization strategy

8 projects plan to commercialize the project results. In 5 of the 8 cases the plan is to use the companies in the consortium to do so, 1 of the 8 of those plans to use a research spin-off and one plans to use a mix of a research spin-off and companies in the consortium. For 1 project it is still unknown what strategy they are going to use. 4 of the 5 projects that use only companies in the consortium to commercialize the project results are close to commercialization, all 5 plan to eventually commercialize. The project using a research spin off has already commercialized. The project using a mix of a research spin-off and commercialization by companies in the consortium plan to commercialize project results but are not yet close.

When companies in the consortium are the ones to commercialize the project results they all commercialize their own part. In all 5 the cases this is due to the fact these companies operate in different markets, but are part of the same value chain.

When a research spin-off is used, the reason given is policy of the institute. The university launching a spin-off is entrepreneurial focussed, They gave students the chance to commercialize the technology. The partners in the project are now suppliers/customers of this spin-off.

The other project planning to use a research spin-off is from a research institute which has a policy of launching spin-off when the technology is ready for it. They plan to commercialize the part they worked on in this project. When a project commercializes project results it seems that partners only commercialize the part they worked on.

There is one exception of this and that is a project that launched a research spin-off. *This will be taken into account further in 4.3*

4.2.2 Variables derived from the case-studies

Additional variables are identified in the performed case-studies, these variables are not based on literature but on the collected data and interviews. These variables are explored for their potential impact on commercialization.

Project characteristics

Coordinating partner

3/10 Projects have a higher education institute as coordinating party, all of these plan to commercialize project results and are close to commercialization. The project that already commercialized their project results was also lead by a University. 2/10 projects were coordinated by a large enterprise. One of these plans to commercialize and none are close to commercialization of project results. 4/10 of the projects are coordinated by a research institute. 3 out of 4 of these projects have plans to commercialize the project results and one of these is close to commercialization. One project is lead by an SME, this project plans to commercialize and is close to commercialization of the project results. When combining coordinator to a research (research institute or university) or industrial (Large or small-medium enterprise) coordinator there is no pattern to be seen. The expectation is that projects with an industrial coordinator are much more focussed on commercialization. In our cases the opposite seems true for large enterprises. Higher education institutes as coordinator seems to work very well for commercialization. *This will be further researched in in 4.3*

Funding scheme

When checking the funding scheme's influence on commercialization there seems to be a connection. However the funding-scheme also influences other variables researched. For example a project with funding scheme CP-IP, a large integrating project, has more partners, a larger budget and a broader scope. 3 projects were funded with a generic CP scheme of which 2 are close to commercialization, whereas all have plans to commercialize the project results. 1 of these projects already successfully commercialized the project results. The project, which is not close to commercialization, had also the characteristics of a large integrating project, a large number of partners, broad scope and a high budget. 3 projects have funding scheme CP-FP, a project with a focused scope. 2 of these want to commercialize and are close to it. One project does not commercialize the project results but this is because of technological difficulties which could not be foreseen prior to the project. There are three cases that have CP-IP as funding scheme. These are large integrating projects. 2 of these projects plan to commercialize, but none are close to it. One project has the funding scheme CP-TP which is a research project targeted at a specific group, in this case SMEs. This project is successful and close to commercialization of the project results. It seems that funding scheme has an influence on commercialization. This finding is in line with other findings where larger projects with a broader scope seem to commercialize less, while smaller projects with a narrower scope commercialize project results more. *Therefore this variable will be further researched in 4.3*

Project achieved objectives

In the case studies we explored whether or not the project achieved its objectives. Of the projects that are close to commercialization, all achieved their objectives. Two of the projects did not achieve their objectives and they are not planning to commercialize the project results. This follows the line of expectation. In the case studies we also explored whether or not they overachieved or underachieved the project's objectives. In 5 case-studies there was some form of underachieving. Of these cases, 3 plan to commercialize and 2 are close to commercialization. Of the cases that did not underachieve any objectives, all plan to commercialize and 3 are close to commercialization. In 3 projects also overachieved some objectives according to the interviews, they did more than originally planned or technology performed better than expected. Two of those projects plan to commercialize project results and 1 is close to commercialization. A project that achieves its objectives seems to do better on commercialization of the project results. This is in line with expectations and *will therefore be further researched in 4.3.*

Good project management

In 2 projects there were some troubles with project management. In these projects there are no plans to commercialize the project results. Of the remaining 8 projects, all plan to commercialize the project results of those 5 are close to commercialization and 1 has already commercialized project results. Here it also seems that projects that have good project management according to the interviewees have a better chance to commercialize project results compared to those who do not. *This will be further research in in 4.3*

Good collaboration

The 2 projects where project management was a problem, collaboration was also a problem. 2 other projects had some minor collaboration issues but it seems that this didn't influence commercialization of the project results. These two projects both plan to commercialize project results of which one is close. The effectiveness of collaboration seems to be linked with the effectiveness of project management. *Together with project management it will be further researched in 4.3*

Large number of partners perceived as problem

In 4 of the cases the large number of partners was explicitly mentioned as a problem by the interviewees. Of these 4 projects only 2 plan to commercialize. None of these projects are close to commercialization though. Of the other 6 projects all have plans to commercialize, 4 are close to commercialization and 1 is already commercialized. *The number of partners will be further researched in in 4.3*

Commercialization

Received ESIC Services

ESIC services stands for exploitation strategy and innovation consultant services. In short these are services given to project participants to help identify potential exploitation opportunities and difficulties and helps with the exploitation strategy of the consortium. 7 projects in the case studies received these services, all interviewees mentionind that these services were perceived as helpful. However in the 10 cases there seems no difference in commercialization between projects that received these services, and those who didn't. *Therefore this variable will not be elaborated on in 4.3*

Technology commercialized in parts?

It is interesting to see that a lot of commercialization is done by multiple organisations. In 2 cases this is expected because these projects develop multiple products. Of the 8 cases that plan to commercialize, only one has commercialized the technology as a whole. This was done by the use of a research spin-off. In all other cases multiple partners commercialize the technology. This could be because of the value chain that is covered in these projects. Each step in the value chain requires a different technology. From the case studies becomes clear that commercialization in parts seems to occur when companies in the consortium are responsible for commercialization.When commercialization in parts occurs the project participants tend to commercialize the part they worked on. *The link between commercialization strategy and commercialization in parts will be further researched*

Involvement of end user or end user association

One of the project enablers that interviewees regularly mentioned was the involvement of end users or end user associations. Interviewees mentioned that having direct feedback from an actual user improved the project results. Of the 4 projects that actively involved the end user over the course of the project. 3 are close to commercialization. The project that isn't close is just started but mentioned that the positive influence was already noticeable. *The involvement of end users or end user associations seem a good driver for the project and will be further researched in 4.3.*

4.3 Elaboration of strong predicting variables

In 4.2 we have scanned the variables on their influence on commercialization. Variables that seemed to have a relationship with commercialization will be further elaborated in this paragraph. Here we look closer in the cases and the interviews to uncover the relations between variables. At the end of this chapter a set of variables is found that had an influence on commercialization according to the cases. These will be verified with more cases that were performed for the evaluation of FP7-NMP to strengthen the findings of this research in 4.4

4.3.1 Project Size

The size of the project seems to be a strong determinant for a project to commercialize the project results or not. From the cases it became clear that large projects with big budgets and a large number of partners do not commercialize the project results that often. What these projects have in common is that they are mostly labelled as 'large integrating projects'. The focus of these projects is to combine several technologies into a new concept. An example of this could be the creation of an energy efficient district, using several technologies such as thermochemical heat storage, smart grids and other technologies combined to get a district energy neutral. These are the projects that are highly visible and use large pilots or demonstrators. Of the 10 cases researched 4 fall into this category. 3 of these projects have plans to commercialize what they developed, none are close however. The projects have budgets ranging from €7mln to €12mln and have a number of partners ranging from 17 to 20. The concepts developed in these projects, will not be commercialized as a whole. This is due to the combination of different technologies, of which some might not be ready for commercial exploitation. From a research and development perspective these projects can be seen as a success, as all these projects met their objectives. These projects prove that some technologies can be up-scaled or used in a different environment or the projects expanded the scientific knowledge on a subject. However commercialization is not the main goal of these projects. The industrial partners working in this project use their own technology in this project. This helps them the improve the technology or gets them attention. No new technology was commercialized in these cases, but it certainly helped the companies in these projects. In some of the cases the interviewees mentioned that the project helped their company through the economic crises without cutting on employees or even worse, going out of business. When commercialization is the goal it seems that large integrating projects are not successful in doing so.

Smaller projects however seem to be more successful in commercializing the technology. The project with the least budget and the least number of partners is in fact the only one of the 10 cases that successfully commercialized the technology . In this project the collaboration was very efficient because it was small. It was mentioned as one of the enabling factors in this project. The 6 smaller projects of the 10 have a budget from €3,5mln to €5,5mln and have 7 to 14 partners. Of these smaller projects 4 are close to commercialization and one already commercialized project results. One project does not have plans to commercialize. The characteristics of these projects is that they focus on a single technology or product. An example of this is a new type of lightweight insulating glass. There are fewer problems and misunderstandings mentioned, smaller research and innovation projects are easier to manage. The project that did not commercialize had some troubles with the large number of partners and on top of that the technology underperformed.

Smaller research and innovation projects focussed on one technology have less troubles commercializing than the large integrating projects. A research and innovation project being too large is mentioned as a problem by the interviewees in 4 different cases. Several problems are mentioned by the interviewees. In 3 of the 4 cases the fact that it is hard to make a decision and satisfy all partners was mentioned as a reason. In 2 of the 4 cases communication issues were mentioned as a problem. In two of the larger projects (14 and 18 partners), there was no mentioning of the large number of partners being a problem. They solved this problem by splitting the project into three clusters. This is more convenient from a project management perspective. In one case it was mentioned that the focus on integration between the clusters had to be kept in check.

To **summarize**. smaller projects that are focussed on a single technology are more likely to commercialize project results than larger projects that try to integrate several different technologies and have a broader scope. Several reasons for this were found from the cases. The main one that stands out is difficult collaboration and difficult project management. Splitting the project in smaller 'sub-projects' seems to help to overcome these problems. When doing this, the project should keep focus on integration efforts to prevent incompatibility with other sub-projects. Technology developed is most of the time commercialized by multiple organizations. In large integrating projects, these technologies are brought together in a larger concept, but none of these companies is going to commercialize these large concepts, either because parts of the technology are not yet developed enough to allow for commercialization or because of the integrating character of these project *require* multiple organizations to commercialize. Large projects are great for research and development, but when commercialization of new technology is the goal of the project, a smaller, focussed project is more suited.

4.3.2 Project management and collaboration

In the previous paragraph some attention was already given to the variables/factors of project management and collaboration. A large consortium makes project management and collaboration harder. The two projects that had some difficulties with project management didn't commercialize because the projects were unable to achieve the objectives set in the project. This also led to difficulties in collaboration. In one of the cases an interviewee mentioned that the focus of the industrial partners was on sales and not on research, resulting in partners not telling the other project partners that they lacked certain knowledge or needed help with their work package. This slowed down the project. On top of that it was mentioned that some important matters were unclear. It was unclear how money was being redistributed when changes occurred, how to get back on schedule and how to deal with partners not having the knowledge to perform their tasks. These problems occurred when it became clear there were some difficulties with the technology. There were some problems with the materials used and the integration of the different work packages. The material difficulties were unfortunate and could not have been predicted beforehand, but better project management and collaboration would have helped with the integration efforts. In the other case where some difficulties with project management and collaboration occurred, the reason of the problem given by the interviewees was the large size of the consortium: it was very hard to make decisions with a large number of partners. On top of that a number of partners were underperforming and there wasn't enough focus on the integration of the different work packages, within the work packages collaboration went well though.

Other projects seem to have good project management. Some solved the problem with the large number of partners with splitting up the project in smaller 'sub-projects' or having double coordination, one on the technological development side and one on the scientific side. Having three sub-projects operating in the same project stimulated the exchange of ideas between the sub-projects. This was one of the drivers of this project. Clearly defined roles and scope is very important for a project to stay on schedule. An example of a project that has just started is already delayed for two months because agreements made before the project start were not specific enough. This was overcome and the project is now on its way.

In 4.2.2 was mentioned that projects with a higher education institute as coordinator seemed likely to commercialize project results. But when looking closer to these projects, these were all smaller projects which were easier to coordinate. In the cases there was no evidence that universities were better coordinators than others. The same is true for Large Enterprises. These organisations were leading two of the larger projects of the 10 cases. Therefore the type of coordinator is dismissed as having an influence on commercialization of project results.

To **summarize** the results on project management and collaboration within the project, it seems that difficulties in project management and collaboration is largely due to the relatively large number of partners in the projects. Splitting the project into smaller 'sub-projects' or splitting the coordination seems to help with this according to information from the cases. Besides project size, the interviewees also gave other reasons. Dealing with change and underperforming partners needs to be executed well. There are cases that dealt with underperforming partners by removing them as partner and switching the workload to other partners and there are cases that did nothing to solve the issue of underperformance. Project management of the coordinator is vital to deal with this. Prior to the start of the project the roles, scope and agreements should be clear, else this can lead to delays or work package integration difficulties. There was no evidence in the cases that suggests that the type of coordinator has influence on the project results and commercialization efforts. While project management and collaboration have no direct influence on commercialization, they do have an influence on the project success and productivity of the project partners, a successful project increases the likelihood that technology developed will be commercialized.

4.3.3 Value-chain partners and End users

All the cases have partners from different positions in the value chain. In 6 of the cases this was explicitly mentioned as one of the project enablers. 4 Of the cases invited one or several end users or end user associations in the project and all of them mentioned this as very helpful in the project. It helps in getting direct feedback from the users. One of the projects said that the end users were so engaged that they already asked for deliverables that were planned for the next year, the interviewee said that this motivated the project partners. When the technology is developed for a specific market, the inclusion of end user associations gives access to those for which the technology is developed. Involving end users also stimulates interest in the finished product. In another case end users were already asking where they could buy the finished product before the project was finished. Developing technology that fits the needs of the end users is one of the requirements for successfully commercializing new technology. If there is no need, there is no market. This is also reflected by the results for commercialization. 3 of the 4 projects that involved end users or end user associations are close to commercialization. The project that is not close has plans to commercialize and has just started, for them it is unknown if the project results are ready to be commercialized after the project is finished. **The involvement of partners from the value chain and the involvement of end users are positive contributors to commercialization according to the 10 cases researched.**

4.3.4 Project success

Achieving the objectives of the project is one of the enablers of commercialization. This seems pretty straightforward. Some factors that influence project success are identified and some of them have already been discussed in the paragraphs above. The projects that did not achieve their goals (2 out of 10 cases) do not even plan to commercialize the results. Reasons for failure in this project were mostly technological difficulties, the technology being too expensive for commercialization or not meeting the expectations. In one of the 2 projects the technological failure can be traced back to project management. In one of the interviews a partner mentioned that the coordinator was reluctant with applying changes in the project, when they were needed. Changes were needed because of these technological difficulties. In the other project the technological difficulties can be traced to the large number of partners. The project required strict integration of different technologies which made it harder to collaborate. Furthermore it required a standard to be adopted. These are issues that might have been tackled with a more experienced project manager or coordinator.

All other 8 projects plan to commercialize their project results, 6 of them have met all their objectives of which 4 are already close to commercialization. 1 of the projects did not achieve all the requirements because it was technologically impossible, they had to make a trade-off between different properties of the technology. They are close to commercializing, but will do so in a niche market and not the mass market they envisioned at the start of the project. One project just started so it is unknown whether or not they will meet the objectives.

Of the 2 projects that did not meet the objectives, TRL seems one of the predictors. 2 of the projects mentioned were on level 3-4, which is still an early stage of technology readiness. The third project has a TRL of 7+ but does not commercialize because of standardization and collaboration issues. Both of them had troubles with the technology. One can't compete with the current standard in its current state however that technology is going to be commercialized in niche markets. The other project had also some technological difficulties. This is expected as the technology is still in an early stage of development. This suggests that for a technology to be ready for commercialization after a project, it needs to be at least at level 5 to increase the likelihood of project success. Else a more 'traditional' type of FP7 project could be more appropriate instead of a PPP focussed on commercial exploitation. With uncertain technology however it is possible that the project plan has to be changed. The project coordinator should help with this.

4.3.5 Commercialization of project results in parts

One of the interesting facts of these research and innovation projects is that every partner that is interested in commercialization only commercializes the part they worked on. This also largely explains the commercialization strategy used. All 10 projects included partners that cover the value chain. The technologies observed require developments in the entire value chain. It is therefore hard for a single organization to commercialize *all* the developments. Rather the partner that is already active on a position in the value chain will commercialize what they developed in the project. Not surprising as these companies want to have some form of return on their investment. In 6 of the 10 cases different organisations will commercialize different parts. In one this isn't the case and an academic spin-off is used. This spin-off uses the other partners as suppliers of the spin-off. That is the only example in the cases that uses a different approach on commercialization. When asked for the reason why this strategy was used, the interviewee answered that their university focuses on entrepreneurship and had students interested in commercializing this technology. Furthermore it was a risky investment for companies that operate on different markets the interviewee said. In this project also a platform was developed which is commercialized by another company in the consortium, this was only a small part of the project however, but illustrates that multiple organisations commercializing different parts of the project results is very common. Most of the time the industrial partners are the partners that commercialize the technology to get a return on investment this way.

4.3.6 Technological context

The last point that is being discussed is technological context. In this research project the aim was to control for differences between technological domains. In 4.3.4 TRL was already mentioned as a factor for project success and the subsequent commercialization of the project results, however the initial scan of the cases suggested that projects under the Energy efficient Buildings theme commercialize less than projects under the Factories of the Future theme when looking at none of other variables. However it seems that theme is not of influence on commercialization between the two. 3 Of the 4 large integrating projects in the case studies have the EeB theme. In 4.3.1 was already suggested that large integrating projects are less likely to commercialize project results. Furthermore the EeB cases included 3 projects with a TRL of 3-4, which was already identified as a cause of some of the project results and subsequent commercialization. Furthermore none of the interviewees mentioned difficulties specifically related to the technological domain as a barrier for project success or commercialization when asked for scientific and technological barriers. Therefore the technological context as having an influence on the commercialization of the project results is rejected. What is of influence and already mentioned in 4.3.1 is the scope of the technology. Large integrating projects with a broader scope and multiple technologies are not likely to commercialize project results, while projects that focus on a specific technology are more likely. It cannot be concluded that the technological theme is of influence on the commercialization activities.

4.3.7 Summary of case-study results

From the case study analyses, it turns out that project size is the most obvious determinant for commercialization of project results found. Generally speaking larger projects with more partners commercialize less of the project results. Reasons given for this are difficulties making arrangements with all partners, some of the technologies used were not ready for commercialization after the project or there is no partner able or willing to commercialize these large concepts requiring many partnerships and integration, these project are probably better suited for more scientific and technological advancements rather than commercial exploitation. Smaller projects focussed on new or improved technology instead of integrating existing technologies are more likely to commercialize. These projects have less overhead and are generally easier to manage and have better collaboration, on top of that, a new technology is easier to commercialize for an organisation than a large concept of integrated technologies. No evidence was found that the amount of funding had an influence on the commercialization of project results.

However this does not mean that the large projects should be stopped altogether. Of the 4 larger projects 3 achieved the objectives and one has just started, 1 of the 3 didn't achieve the goal of a commercially viable product at the end, but achieved all other objectives. The costs were too high to be commercially viable according to one of the interviewees. 2 of these 3 projects didn't commercialize for different reasons. One has developed technology which is still too costly, and the second has fully developed technology that needs standardization before commercialization and another technology that needs further development before it can be commercialized. Other technologies used in the second project were already proven technologies that were used for the demonstrator. One of the large projects plans to commercialize when the project is finished. This project is split into smaller parts to reduce the overhead, but work together on the demonstrators.

Project management was also one of the factors that influenced on the commercialization of project results. Generally the larger projects have more issues with project management and collaboration. To cope with these issues in large research and innovation projects, some have split project management into two roles or have split the project in smaller 'sub-projects' to make them easier to manage, one of the important things is for every partner to have a clearly defined scope and role in the project and deal with changes accordingly instead of ignoring it. It should be noted that good project management has an influence on project success rather than commercialization, but project success is essential for commercialization. Factors that further help achieve project success besides good project management is having more mature technology at the start of the project, else the chance that the technology is not ready for commercialization at the end of the project is higher.

It is interesting to see that technology developed in the project is commercialized by multiple companies in the consortium. Not surprising as these cases all have partners across the value chain. In most cases technology is commercialized by the company that also worked on that part within the project. Another positive aspect of the value chain perspective is that having an end user or end user association involved within the project, enables the project partners to get direct feedback from a relevant environment while they are still developing the technology. It also keeps the technology close to the user needs, probably making it more interesting for potential clients to purchase this technology.

The difference in theme (EEB versus FoF) was not of influence on commercialization in the cases that we analysed. The reasons given for project failure were not because of the technological domain of the project, but more on how the project was structured, across both themes.

4.4 Validation of results

In this section the results of the case studies are verified. This is done in order to increase the strength of the findings. For validation of the results, more cases that were part of the FP7-NMP evaluation were analysed. The results of the analysis in 4.3 will be compared with other cases that were performed for the FP7-NMP evaluation. Here we will look at projects that have a technological focus with a TRL of at least 3-4 (This excludes the basic science projects) which include partners from the industry. In this section the influence of project size and type of project, large integrating projects versus smaller projects focussed on a single technology, on commercialization will be evaluated. Here we take into account the influence of project management and technological maturity at the start of the project. The last thing checked in the other cases is whether or not multiple organisations commercialize technology or other commercialization strategies are used.

19 of the 41 cases performed for the evaluation of FP7-NMP fit the requirements of the validation set. Of these 19, 8 have a TRL of 3-4, 7 have a TRL of 5-6 and 4 have a TRL of 7+ at the start of the project. The number of partners range from 6 to 26. Of the 19 projects, 6 are a small-medium sized focussed project (CP-FP), 6 are large integrating projects (CP-IP) and 6 are projects focussed at a specific group, in all 6 cases focussed on

the specific group these are SMEs. The last project is a generic project but has the most in common with focussed projects. Of these 19 projects, 2 projects have already commercialized their technology and 3 are close to commercialization. 7 More projects have plans to commercialize but are not close yet, some (non-technical) hurdles have to be overcome such as standardization. When projects have plans commercializing or commercialized the technology, this is done by industrial partners in parts in 9 projects. In one case the technology is licensed and in another case a single company commercializes technology. For one case there was no information on commercialization given in the case. 14 of these projects had good project management, 3 had not and of 2 there was no information on project management. 15 Of the projects had partners spanning the value-chain while 4 did not have this. 11 Of the projects involved the end user in the project and 8 had no end user involvement. 4 Projects were split into smaller projects.

4.4.1 Project size

The most important project size indicators identified in 4.3 are the scope of the project and the number of partners. The focussed projects range from 6 to 14 partners, the large integrating projects range from 15 to 26 partners and the projects focussed on SME participation range from 12 to 25 partners.

Looking at the 7 focussed projects, 4 have plans to commercialize, 1 is close to commercialization and 1 has already commercialized technology. 3 Projects have no plans to commercialize. In all three cases the reason given for this is that the technology is not mature enough for commercial exploitation. These projects all started at the TRL of 3-4. Another project also started at TRL 3-4 but has plans to commercialize, the concept itself didn't work out, but some companies saw opportunities in parts of the project for other applications.

Of the 6 large integrating projects 2 have plans to commercialize project results. None have commercialized and none are close to commercialization. When asked for the reason not commercializing the project results, the technology maturity is given as a reason in 3 cases. The technology being too expensive for exploitation was the reason in one case. In case of commercialization plans there is a project where a Large Enterprise has IP rights on the results when they see commercial opportunities. In another case the technology is implemented in the participating companies to strengthen their offerings. In these cases TRL does not seem to be of influence on the plans to commercialize.

In the 6 projects focussed on SME participation, all have plans to commercialize of which 2 are close to commercialization and 1 has already commercialized. In the project that has commercialized technology, the SMEs were responsible; they are offering modified results on the market. The 2 cases that are close to commercialization are expecting marketable results at the end of the project according to the interviewees. This is because the technology is already of a high TRL and project results are promising. When projects are not close to commercialization, the technology is ready but other factors are of influence. In one case the price of competing material dropped significantly which makes it less interesting to use their solution, in another case the market is not ready yet for this kind of technology according to the interviewees and in another case there is no market yet. They mentioned that end users were not involved and that would have helped with this step. The actual number of partners does not seem to influence commercialization when a project is focussed on SME participation. TRL does however. Of the projects that are close to commercialization, the TRL is 5-6 in one case and 7+ in two cases. In none of the cases the large number of partners was mentioned as a problem.

Considering the results of the 10 cases performed for this research and the 19 cases of the validation set, there is influence of projects size on commercialization of results. Small and medium sized project focussed on a specific technology commercialize results more than large integrating projects. To increase the likelihood of commercialization the technology should be mature enough at the start of the project. A level of 5-6 is indicated as a minimum for likely commercial exploitation. What is interesting from the validation set is that when a large number of SMEs are involved, the number of partners doesn't seem to be a problem anymore. The influence of SME involvement on commercialization seems an interesting topic for future research.

4.4.2 Technology maturity

In 4.4.1 technology maturity is already mentioned as a condition for commercial exploitation. When looking at the validation set, none of the projects that started with a TRL of 3-4 are close to commercialization of project results. Technology not yet mature enough at the end of the project is mentioned in 5 of the 8 cases with a TRL of 3-4 as the barrier for commercialization. On the other end 2 of the 4 projects with a TRL of 7+ have already commercialized the technology and 1 of the 4 TRL 7+ projects is close to commercialization. The project that does not commercialize has a technology that is ready but market developments made it too expensive to commercialize the technology. On the middle ground the 7 projects with a TRL of 5-6 show a mixed view. 5 Of these projects intend to commercialize, of which two are close to commercialization. In the two cases that do not have exploitation plans, the technology maturity is given as a reason. In short technology maturity is needed to some extent at the start of the project to make it likely that marketable innovations are ready to be commercialized at the end of the project.

4.4.3 Project management

In the case of project management being the cause of project difficulties there is not much evidence in the validation set. In only 3 cases difficulties with project management and collaboration was mentioned and in two IPR issues were the problem. These three projects that have troubles are all of a TRL 3-4, and have 14 to 19 partners. 2 projects are of the large integrating type and one is a small-medium focussed project. 2 projects have not achieved their objectives fully and one has. Concerning commercialization none are close and one will commercialize if something exploitable is discovered during the project (in this project a large enterprise is involved solely responsible for commercialization). There is no evidence for or against difficulties in project management and collaboration as a barrier; the cases gave different reasons for project failure. The influence of good or bad project management could not be strengthened in the validation.

4.4.4 Commercialization strategy of project results in parts

12 Out of the 19 projects plan to commercialize or commercialized the project results. 10 of these 12 will commercialize the project results in parts. It is interesting to see that the projects that do <u>not</u> commercialize in parts did not cover the value chain with the project partners. When this is the case a single company was responsible for commercialization. In one of the cases that did not commercialize in parts this was a large pharmaceutical company and in the other case that does not commercialize results in parts this was an SME which now licenses the technology to a large joint-venture which was no participant in the project.

In the results described in 4.3 the inclusion of value chain partners in the project was already suggested as a positive influence on the commercialization of project results, but there was no evidence for projects that did not invite value chain partners.

In the validation set there is. This leads us to conclude that the commercialization strategy used is dependent on the composition of the partners in the consortium. End users as partners in the consortium is also considered as an enabler for commercialization. In 11 of the 19 cases in the validation set this is the case of which 3 explicitly considered this as an enabler. In 2 cases where the end user wasn't involved, the technology cannot be commercialized because they have no clients or market yet.

4.4.5 Project success

The last factor/variable that needs to be verified is whether project success is needed to commercialize. The projects that successfully achieved their objectives are also the ones that are close to commercialization. None of the projects that only partially achieved objectives are close to commercialization. This confirms that projects success makes it more likely that results will be commercialized. This is in line with the results found in 4.3

4.5 Final conceptual model

The conceptual model derived from literature will be adopted with the results from the case-studies and validation of the results. This model is presented in Figure 15. In the model a + means that the factor positively affects the following factor and ∩ means that the factor positively affects the following, but negatively if it gets too big.

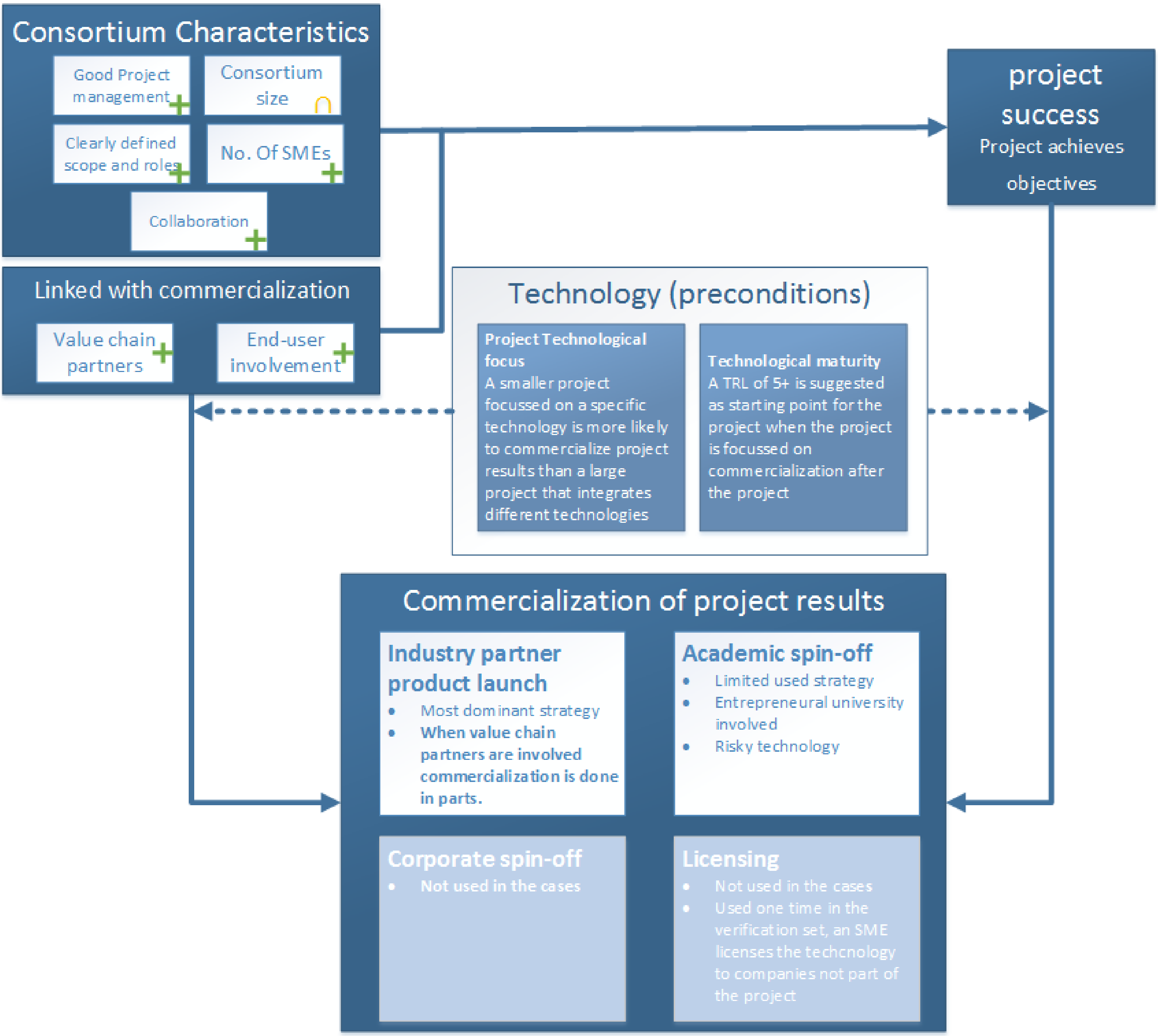

Figure 15: Final conceptual model

Consortium characteristics that have an influence on commercialization are displayed on the left in the model. *Project management* is indicated by interviewees as one of the factors that influences *project success* and *collaboration*. These collaborative projects use complex technology, so when something unexpected happens, the project should be back on track as soon as possible. When this is not done correctly, the chances on project success diminish and collaboration is less effective.

The same is found true for *clearly defined scope and roles*, when project partners know what to do, the project is more likely to be successful, and collaboration is better. When a consortium gets too large, it becomes harder to collaborate. In the larger projects it is harder to make decisions and to keep an overview what everyone is doing. In the validation set is found that when a large amount of SMEs is involved, the large number of partners is not perceived as a problem. We did not find an explanation for this phenomenon, this is a good topic for further research.

When value chain partners are involved, it seems that the collaboration is better. In the cases this was also mentioned quite a few times as an enabler for commercialization. When value chain partners are involved, the exploitation will likely be performed by the companies themselves. They do this in parts, exploiting only their part of the value chain. Involving end users is an enabler for commercialization because you can directly tune the technology for the end user, thus increasing its market potential. Getting direct feedback from the end user also improves collaboration in the consortium

The technological domain is found not to influence the commercialization of project results. However different technological properties have an influence on the commercialization. The first is that the project should use a mature enough technology. When a project starts at a minimum of technology readiness level 5, it improves the likelihood that the technology is ready for commercialization at the end of the project. In the cases we discerned two types of projects: integrating projects and focussed projects. The difference between the two is that an integrating project uses many different technologies and combines them into a new technological concept. The cases show that the concepts themselves are rarely commercialized. Sometimes a specific part of the technology is being commercialized. Focussed projects, which develop a single technology, are more likely to commercialize. The outcomes of these focussed projects are of a scope that can be commercialized by a single company, unlike the large concepts of the integrating projects. Therefore, when aiming for commercialization shortly after a project has ended, the project should focus on a single technology.

The strategy of commercialization that is most used is a project partner who commercializes the project results. This is their return on investment. One case used an academic-spin off. An entrepreneurial university led this project and the technology was still risky. The other two strategies are were not found in the cases that were analysed. In de validation set one case of licensing was found. No reason given was given why licensing was chosen, but an SME is licensing the technology to other companies which were not part of the project.

5 Conclusion and discussion

This research started with a problem. In the EU, research findings are not commercialized very often. A troublesome transition exists from research to innovation. This is sometimes called 'the Valley of Death'. The Valley of Death relates to a gap in funding, support and skills gap. Basic research can be funded by research grants, are supported by universities or research institutes and is carried out by scientists. When research matures and becomes more development oriented, the amount of available funding decreases, other skills are needed to further develop the technology, one of which are commercial skills, skills researchers usually do not have. When the technology is past this phase more funding, support and skills become available. Funding becomes available from for instance venture capitalists, equity or commercial debt. These forms of funding require a sufficiently mature technology to reduce the risk for investors.

The European Commission acknowledged the problem of the Valley of Death. Inventions from research are not commercialized often enough. To help overcome this 'Valley of Death' the European Commission launched a public private partnership structure in the 7th framework programme as part of the European Economic Recovery Plan. This thesis focussed on research & innovation projects funded by the EU and the subsequent commercialization of project results. From a literature review it became clear that limited research to date has been performed on the commercialization of project results performed by European research and innovation consortia.

The research questions and the answers are described in 5.1, including a discussion on the main findings. Limitations of the research are presented in 5.2. This research had some interesting findings on which further research is needed, they are presented in 5.3. This chapter ends with a reflection on the research done and lessons learned during this research project

5.1 Conclusion

Our research focused on commercialization of project results by research and innovation projects funded by the EU. The European Commission actively steers on commercialization of project results. This became more prominent when the economic crisis started in 2007. In our study we focused on those research and innovation projects that aim to eventually commercially exploit the project results. This research aims to give recommendations on how to *design* research and innovation projects in such a way that it stimulates commercialization of project results by looking at the characteristics of research and innovation projects. The following main research question is formulated for this purpose:

What consortium characteristics of research and innovation projects, when taking into account the technological context, stimulate or hinder commercialization of these projects?

8 sub-questions were formulated in order to answer the main research question:

- What does the literature say on consortium characteristics and their influence on research and innovation projects results/deliverables?
- What does the literature say on commercialization of the results of research and innovation projects?
- Which theoretical concepts help to explain differences in technological context?
- Which commercialization activities and strategies are used in European research and innovation projects?
- Which consortium characteristics affected the commercialization activities?

- What is the influence of the technological context on commercialization of research results in research and innovation projects?
- How does a conceptual model look like that shows what the relation is between commercialisation of project results and project characteristics taking into account the technological context?
- How should future research and innovation consortia be designed in order to achieve a higher rate of Commercialization of research results?

The combined answers to the sub-questions result in an answer to the main research question, including recommendations for the European Commission to stimulate commercialization of project results. In the next sections the sub-questions are answered.

Sub-question 1: What does the literature say on consortium characteristics and its influence on research and innovation projects?

To answer this question existing scientific literature was used. Our literature review showed that limited literature is available that directly links consortium characteristics to commercialization strategies. For that we looked into the broader literature regarding research projects and we found influences on project success factors, effectiveness of collaboration and productivity. It is unknown how these factors influence the commercialization of project results but it gave a starting point for further research. In this research project one of the objectives is which these three factors positively affect commercial performance.

According to literature, factors positively influencing research productivity are collaboration with other researchers (Landry et al., 1996). The reason for this is that the collective knowledge in the project increases. The amount of public funding also increased the productivity as it ensured that more researchers could work together (Godin, 2003). The same is true for private funding. The reason given for increased productivity when collaborating is the pooling of researchers and funding (Barbolla & Corredera, 2009).

When considering private funding it also helps with project success (Barbolla & Corredera, 2009). Other than public funding, private funding gives the project a sense of urgency. This stimulates researchers to make the project a success. The other point found in literature that increases project success is clearly defined roles and scope at the start of the project (Barbolla & Corredera, 2009). The project will not be a success when something at the start is still unclear. This can lead to delays in the project schedule or even project failure.

Effectiveness of collaboration has more to do with which partners are involved in research and innovation projects. In the literature was found that diversity in partners stimulates collaboration (Raesfeld et al., 2012). These partners should have the same basic knowledge of the subject. When partners are too diverse, the effectiveness goes down. More concretely: partners that operate along the same value chain make excellent partners. When competitors are involved as partners the effectiveness goes down. Issues with IPR or company critical information make these partners reluctant to share information within collaborative research projects (Nieto & Santamaría, 2007). Lastly the size of the consortium is of influence on a research and innovation project. Involving multiple partners increases collaboration effectiveness but only to a certain extent. Very large projects have difficulties with project management and integration of work, which means that the effectiveness goes down when a project gets too big (Fontana et al., 2006).

These characteristics identified in literature formed the basics for analysing the case studies. Within the case studies, we explored the influence of each characteristic on the commercialization strategies of project results by consortium partners.

Sub-question 2: What does the literature say on commercialization of the results of research and innovation projects?

In our literature review on commercialization we retrieved revealed common strategies to commercialize research. We found licensing of technology, academic spin-offs, corporate spin-offs, public procurement for innovation and companies launching innovations into the market. The literature gave insight into motivations for the use of specific strategies.

Licensing is used when a technology is ready for use another organisations can/wants to commercially exploit this technology (Thursby & Thursby, 2011). This requires a mature enough technology to be successful. An academic spin-off on the other hand is suited for technologies that still need a bit of development and are based on a high degree of knowledge on the technology. Downside of this strategy is funding. Once the initial capital is spent, the academic spin-off has a hard time getting funds, because the technology is usually still a high risk for investors (Shane, 2004). A corporate spin-off is however supported by the parent firm. This type of spin-off occurs when technology is developed which does not fit the core business of the parent firm but is promising for commercial exploitation. Also in this case the technology needs to be of an acceptable risk (Festel, 2013). The last strategy is a company that brings an innovation to the market under its own name. This is also done when technology is of an acceptable risk and fits within the company's market orientation. Public procurement for innovation is used when a public organisation wants to procure something that has to be developed yet, this stimulates the final phase of development just before commercialization (Edquist, 2009).

Consortium influence on commercialization is light in literature. One article by Hall et al. (2003) showed the influence of including universities in research and innovation projects on commercialization. They found that the inclusion of universities does speed up the time to market but that larger projects don't speed up commercialization. Smaller projects are more like to speed up commercialization.

Sub-question 3: Which theoretical concepts help to explain differences in technological context?

In this research three theoretical concepts were explored which can be used to explain differences between technological domains if these are found in the data. The cyclic innovation model, the technological systems of innovation concept and the triple helix concept were considered. The technological system of innovation approach was found the most suitable. It is a widely used concept; it focuses on the whole context in a certain technological area and therefore has the appropriate scope for this research. The unit of research in this project is a research and innovation project and the consortium executing it. That is why the cyclical innovation model was not suitable for the purpose of this research, because this model focuses on the interaction within actors in a certain context. The purpose of the model for our study would be to help explain technological differences, not interaction between actors. The last model, the triple helix is of a too broad scope to be usable for this study; it is not suitable to compare different technological domains. This is why the systems of innovation approach was chosen.

Sub-question 4: Which commercialization activities and strategies are used in European research and innovation projects?

For this question the data collected for this research is used. In the 10 cases used for this research the project that have plans to commercialize usually use an industrial partner to commercialize. From the 8 cases that plan to commercialize, 7 use the industrial partner to commercialize of which one also plans to use a research spin-off for a part of the project results. One project uses an academic spin-off. The academic spin-off is launched because the university coordinating the project is entrepreneurial focussed and had students interested in the technology, on top of that the technology was considered risky for industrial partners. However, most projects use industrial partners to commercialize. It is interesting to find that companies do not commercialize a single technology. In the cases a value chain approach is adopted and partners commercialize the part they worked on. This means not only the product at the end of the chain is commercialized but also for example tools that help to create that product. The validation set of 19 other case studies also performed for the evaluation of the FP7-NMP evaluation confirmed this. In the validation set we also found that most projects let the industrial partners execute the commercialization activities.

Sub-question 5: What consortium characteristics affected the commercialization activities?

The project size is the most important characteristic influencing commercialization. This characteristic was already identified in literature. While in this research we could not identify that consortium partners collaborate more efficiently when more partners are involved, this research found that the projects that have a larger number of partners have more difficulties with project management and collaboration. This is connected to the technological focus, which will be further elaborated at sub-question 6. It seems that projects focussed specifically on SME participation can include more partners without the negative influences of having a lot of partners. In the 10 cases in this study only one case was focussed on SME participation. The scope for the SMEs in the research and innovation projects is smaller. This was found in 6 cases that were focussed on SME participation in the validation set focussed on SME participation. In the 10 cases performed for this research no evidence why this is possible was found. This is an interesting topic for further research.

Covering the value chain seems to have a positive influence on commercialization. Each industrial partner involved wants a return on investment. When involving a value chain you ensure that developments that are needed earlier in the value chain are in fact developed within the scope of the project. Involving end users, which can range from industrial end user to consumers, is mentioned multiple times as stimulating for commercialization. Involved end users are very eager to try out developments and to give direct feedback to the project partners. This also ensures that the technology fits the users' needs, thus making it more interesting for commercial exploitation. This view was also confirmed in the validation set.

The cases gave evidence that good coordinator and project manager stimulates project success and collaboration. This is especially important in larger projects. A best practice identified is splitting up the project in smaller sub-projects if possible. One of the pitfalls when using sub-projects is that integration does not receive sufficient attention. In the cases there was evidence for both enough attention to integration and not enough attention. When a project is not clearly defined at the start, it causes delays. Evidence from the cases shows this. One project that was just started had already 1,5 month delay because of vague project descriptions. In the validation set there was an extreme example where IPR issues caused a delay of 1,5 year.

Sub-question 6: What is the influence of the technological context on commercialization of research results by consortia?

For the 10 cases two different themes within FP7-NMP are chosen. These are called Factories of the Future and Energy Efficient buildings. Factories of the Future projects are related to the manufacturing industry and Energy Efficient Buildings to the

Construction sector. There were no differences in technological context when checking for the other characteristics that were found of influence in this research. On top of that none of the cases indicated that project results are or are not commercialized because of their specific technological context.

However, the findings did give other insights into the technological context. If commercialization is the goal of the project, the technology needs to be mature enough and the focus of the project should be on developing a single new technology rather than a large project focussing on integrating several technologies into a new concept. For technology maturity the technology readiness level is used as a measurement. We do note that in larger projects this is not accurate as several technologies are combined which are not all of an equal TRL. In that case the average TRL was taken and is verified with the interviewees. Projects that commercialize or are close to it are mostly projects that have a TRL of 5 or higher. Projects that are of a lower TRL are not mature enough to expect the technology to be ready for commercialization at the end of the project.

The scope of the project is also very important. In the cases two types of projects could be distinguished: small-medium scale focussed projects and large integrating projects. The focussed projects focus on a single technology that will be developed. And the integrating projects are projects creating a concept by integrating different technologies. Combining several technologies for an energy efficient district is an example of this. The focussed projects commercialize more technology because companies can commercialize these technologies on their own. The bar for commercialization is therefore lower. Commercializing the large concepts requires extensive collaboration, making it harder to eventually commercialize this technology.

While the large projects do not seem to explicitly commercialize technology, it can be used to gain more interest in existing technologies, show that it can be used in a real life environment or show that the technology can be applied on a larger scale. The larger projects are sometimes more radical and take more risk than the smaller projects. These large integrating projects are good at creating scientific and technological progress. They could increase sales through the attention of the demonstrator, apply their technology in a new area or apply the technology on a larger scale. In the results of case studies it seems that project results are less likely to be commercialized. This is a limitation of this study as the scope of this research is commercialization of project results; we studied commercialization of the technology developed in the project

The difference between large integrating projects and small/medium sized focussed projects seem that small projects focus on the final step of technology development and prove that the technology is ready for commercial application while large project are more suitable for radical innovation, scaling up or interdisciplinary cooperation and application.

Sub-question 7: What does a conceptual model look like that shows the relation between commercialisation of project results and project characteristics taking into account the technological context?

The conceptual model is based on the answers of the sub-questions 4, 5 and 6, it is shown in Figure 15. In the model a + means that the factor positively affects the following and a ∩ means that the factor positively affects the following, but negatively if it gets too big.

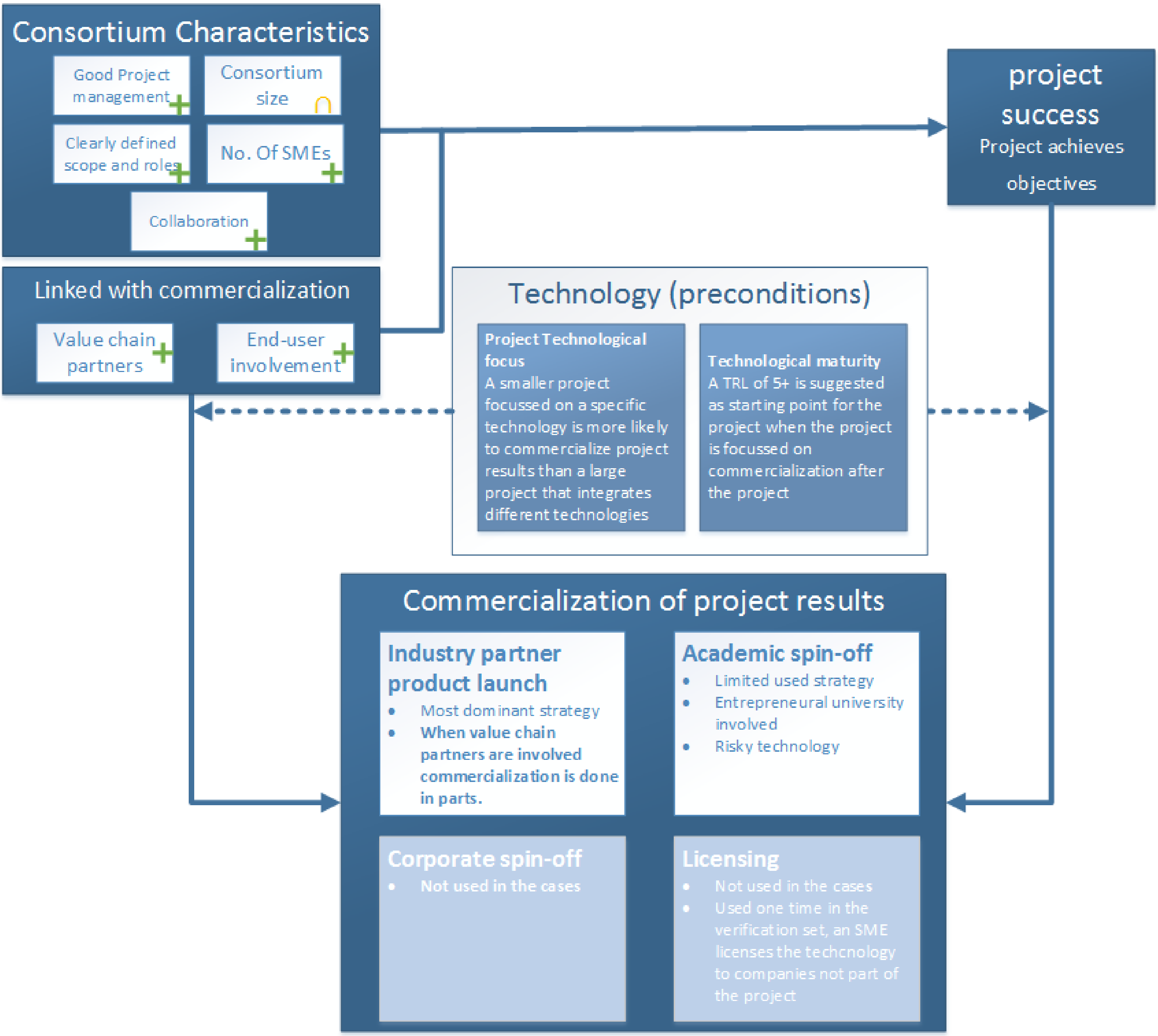

Figure 16: final conceptual model

Sub-question 8: How should future research and innovation consortia be designed in order to achieve a higher rate of commercialization of research results?

If the European Commission wishes to stimulate commercialization of project results within their research programmes, then the following design guidelines should be taken into account. These recommendations are based on the conceptual model that is found above in Figure 15: final conceptual model

- The project participants should cover the value chain;
- Involve end users or an end user association as a project partner;
- Ensure that the roles of the partners and scope of the project are clear before the project starts:
- Have an experienced project manager when the project involves a large number of partners or split the project into sub-projects;
- Ensure that the technology used is at least at TRL 5 or higher;
- The technological scope of the project should be focussed rather than a broad integrating project when commercialization of the **results** directly after project end is a goal of the project
- When a large project is used, also use mature technology, developing new technology and applying it in the same project is too ambitious.

Main research Question: What consortium characteristics of research and innovation projects, when taking into account the technological context, stimulate or hinder commercialization of these projects?

The sub questions answered above lead to the answer to the main research question. Consortium characteristics that are identified as having an influence on commercialization are project size, project collaboration, project management, achieving project objectives and involve partners from the value chain and involving an end user as a partner in the project. Sub question 5 gives the answer in detail. Project size is the strongest consortium characteristic in terms of having an influence on commercialization. Larger projects in the cases are projects that bring in technology that needs to be integrated into a new concept. In these projects, different existing technologies are integrated and their scope is broad. Partners in these projects bring in technology that needs to be adapted or further developed, but the integration of these technologies is the focus of the project. The outcome of the project is a technological concept. In the cases that we analysed, we found evidence that the technological concept is rarely commercialized. For the partners the focus is on their technology. They want to improve the technology or get attention for their technology. This means that these projects rarely commercialize a new technology, but improve existing technology (which could already be on the market). The technological scope of the project together with the number of partners should be kept limited in order to stimulate commercialization of project results. The larger projects help more with (radical) scientific or technological advances and could help indirectly with commercial exploitation of existing technologies.

On the other end of the project size are the small projects focussed on developing a single technology. Generally these projects have fewer partners than the projects with a broader scope. Evidence from the cases suggests that these projects are more likely to commercialize their results compared to the larger projects. Reasons for this are less difficulties in dealing with a large number of partners, but most of all, when industrial partners are involved, they focus on a specific part in the project. Technologies that are developed in these projects require cooperation across the value chain. All the projects that we analysed had participants that covered the value chain. This seemed to work well as partners collaborated on the project as they focussed more on the technology at their position in the value chain. After the project, the industrial partners are free to commercialize the part that they developed. They do so in parts most of the time. This is an interesting finding as not one partner is responsible for commercialization, but each partner commercializes their own part.

The value chain was already mentioned as enabling commercialization. However the end user is not always involved. In the cases evidence was found that the involvement of the end user also enables commercialization. Two reasons were given for this. The first is that the project partners get direct feedback on developments done, and the second is that the technology developed has more fit with the needs of the end user, which is needed for commercial exploitation.

The last influencing characteristic is project management. This was mainly an issue within larger projects because it made it hard to make decisions in the project which all partners agreed upon. Splitting the project into smaller subprojects seems to work well when enough attention to integration efforts between the sub-projects is given.

Lastly the technological context was taken into account. In the cases no evidence was found that the theme (Energy Efficient Buildings or Factories of the Future) had influence on the commercialization of project results. However two technological factors are of influence. The first is the technological scope of the project, projects with a smaller scope are more likely to commercialize than projects with a broader scope. The second is technology maturity. In the research technology readiness level is used as measurement. Our findings suggest that the technology should be at least TRL 5. Projects below that level rarely develop technology that is ready to be commercialized at the end of the project.

This means that if the European Commission wants to stimulate commercialization of technology it should be done with projects that are small of scope, invite value chain partners including the end user and, if the number of partners is high, ensure that an experienced project manager is involved and the technology should at least be at TRL 5 at the start of the research and innovation project.

The scientific relevance of this study was that commercialization of project results from the perspective of the research partnership. This exploratory research is a starting point that can be used as a starting point for more research on this topic. The societal relevance of this research is that now the European Commission can make better decisions on call formulation when they have commercialization of project results as a goal in European research programmes

5.2 Research limitations

This research has some limitations that should be acknowledged. The first and most important one is that the cases focus on a new type of project within European Framework Programmes, the public-private partnerships. These projects were introduced in 2009. Because of this novelty, the projects were not yet finished or had just finished. Therefore a lot of the results are based on progress in the reports and concrete plans to commercialize. This is also the reason that from the 10 cases only one has already commercialized the technology. This is the first research evaluating this type of projects and should give guidance for further research on this topic. To overcome this limitation the interviewees should be approached when all projects are done and had the time to set up commercialization.

The data used was collected for the evaluation of the Nanosciences Nanotechnology, Materials and new Productions theme of the 7th framework programme (FP7-NMP in short). This evaluation did not focus solely on commercialization of project results. In the 10 cases used for this research more attention is given to commercialization, but for the other cases performed for the evaluation this was not. The validation set therefore has less information on commercialization than the cases used in this research. However without this evaluation, access to confidential sources and contacts for interviews would be much harder. Because the data was collected for the FP7-NMP evaluation, it can be generalized to projects that fall within the NMP theme. It is unknown whether the results can also be applied in other research and innovation programmes the EU and Member States have running.

This research focussed on a specific aspect, namely consortium and project characteristics, that has an influence on commercialization. The research had little focus on institutions such as subsidy policy, call formulation, and programme focus. It is possible that these institutions have great influence on the results in this research. The recommendations given in this research do not guarantee that technology will be commercialized at the end of the project, but will increase the likelihood that technology will be commercialized.

Not much research has been done on this topic prior to this research. Therefore an exploratory research has been performed. Existing literature on research projects is used as a starting point. Because there was little literature on this topic, characteristics that have an influence on commercialization might have been missed when collecting the data.

The last limitation of this research concerns the confidentiality in this project. The interviews and documentation from the European Commission are confidential, and can therefore only be shared on an aggregated level. In the body of this research report no specific project is referenced when confidential information is involved. Sometimes an example is given, but that is based on publicly available data. Furthermore the FP7-NMP evaluation has not yet been released to the public. The confidentiality of the information limits the level of detail for reporting the research findings.

5.3 Suggestions for further research

The exploratory nature of this research gives a lot of leads for future research topics. In this paragraph the most prevalent ones are discussed.

The first is to overcome a limitation of this research. This research focussed on projects that were still running or had just finished. A few years after all FP7 projects are finished the research findings can be validated again. It will be clearer which projects have commercialized research findings and which have failed to do so. The conceptual model is a first indication which consortium characteristics are of influence of commercialization. Hypotheses based on the conceptual model should be tested with quantitative data.

The second suggestion is also to overcome a limitation. This research has focussed on a specific themed programme: the FP7 programme. It is not yet known whether the results are generalizable to all EU supported research and innovation programmes. Further research can apply the results of this research in other programmes and see which of the results apply to other research and innovation programmes. Broader research including multiple European R&D programmes using quantitative data is needed to confirm this.

When the case-studies were already being performed the European Commission suggested to include ESIC services into the cases. ESIC stands for Exploitation Strategy and Innovation Consultants. These services help projects with the commercialization of project results to overcome non-technological risk such as IPR issues, financial issues and regulatory issues that prevent project results from being commercialized. In the cases no evidence was found that this had an influence on the commercialization of project results, however all interviewees that received these services found it to be helpful. The influence of these services on the eventual commercialization of project results is an interesting topic for future research.

In our cases only one was focussed on SME participation. This project was successful and mentioned that the inclusion of SMEs was a driver of the project; it also had a rather large number of partners. In the validation set there were 6 cases that focussed on SME participation. It seems that SME participation stimulates commercialization of project results. What also became clear from the validation set is that a large number of partners in projects that are focussed on SME participation had no problems with the large number of partners. Because this factor became clear in the validation set, it could not be confirmed that the SMEs were in fact stimulating commercialization of project results. SME participation and their influence on commercialization of project results seems an interesting topic for further research.

Pre-commercial procurement and public procurement of innovation was briefly mentioned in the literature review. These forms of funding 'forces' commercialization of research results and is added to Horizon 2020, the follow up of FP7. Future research can investigate whether or not these funding schemes successfully stimulate commercialization of project results. Our conceptual model can be used for this purpose.

The commercial influence of large integrating projects was hard to find using the approach used in this study. This study was of an exploratory nature and the scope was on commercialization of project results, not on other indirect commercial benefits of the projects such as portfolio effects. Another study using another approach should be used to find what the commercial influence is of large integrating projects.

5.4 Reflection

I started working on the thesis on the 14th of April. Initially the intended focus was on ICT innovations within the NMP programme. However after the sampling of projects was finished, it became clear that not enough data could be collected for this purpose, because not enough projects were sampled that had an ICT component. The focus quickly changed to commercialization of research results. The Public-Private partnerships were introduced under the NMP theme of FP7. These public-private partnerships intended to focus on commercialization of research. After some discussions with members of the graduation committee, I decided to focus on commercialization strategies. I started writing a proposal on this topic, while in the meantime I slowly started with the evaluation of some of the cases. Preliminary results showed that little data could be collected for the purpose of that research. When discussing this with my first supervisor and external supervisor, I decided that it was better to change the scope of the research. The focus changed to project characteristics and their influence on commercialization of research results taking into account the technological context. Preliminary results showed that data was available to research this topic. This switching to different topics delayed the kick-off meeting to July where it could have been in May if I didn't have to change the scope of the research often.

The access to data was very good and arranged by Technopolis-group. For this research very rich data could be collected. However the data was collected for the purpose of the FP7-NMP evaluation and not specifically for the purpose of this research.

This limited the scope that this research could focus on, as the data collected should be relevant for the evaluation of FP7-NMP. In the interviews I asked more in depth about commercialization. This gave me enough information for the research. However this wasn't done by the case-study researchers that did the cases in the validation set. The validation set had limited information on commercialization but enough to confirm some of the results. The method of using case studies is in my opinion the best suited for this type of research. There was little information on this topic, so an exploratory type of research was needed. Using several small case-studies revealed the most prevalent issues and enablers concerning commercialization of project results.

The PPP themes were launched as part of the European Economic recovery plan. The PPP themes are based on the multi-annual roadmaps on which the sectors worked before the recovery plan was adopted (European Commission, 2013d). The calls of the PPPs were also formed differently. In the PPPs industry groups were formed with both public and private stakeholders which discussed what calls were issued (European Commission, 2013d). Specifications of the call are already important when considering commercialization, for a large part it forms the characteristics of the project such as scope and technology maturity. It is unknown what the influence of industry on call formation was concerning this research. However these industry groups can help in steering more towards commercialization of research results by taking into account the design guidelines suggested in the conclusion of this research.

Member states are also probably politically engaged in the formation of calls. No evidence is found that support this, but it is likely. I speculate that Member States support research calls in areas that are strongly represented in their state. I could not find any information on what the possible influence is of member states on call and programme formulation.

The last notion I want to make on this research project is that we used a linear approach to innovation. I acknowledge that research and development is not the only source of innovation and is not linear. One case of the past where this is very elaborate for example is the development of the Steam Engine. The steam engine was developed before people knew why it worked. This research focuses on the linear path from science to market. While it is not the only source of innovation, it is *a* source of innovation. It can very well be possible that small projects come forth from a specific result of a large project and vice versa. Or that results from a small project will be up scaled and applied in a larger project. This iterative and non-linear flow of innovation can exist but no evidence of this was found in the cases.

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Appendix A Scientific Article

Separate document

Appendix B Initial Sampling

TAGS	GREENLION	ENEPLAN
PHOCAM	FASHION-ABLE	NANOCHARM
BIOAGROTEX	CASCATBEL	ECNP-GROWTH
TRIBUTE	BUGWORKERS	SWARMITFIX
DIPLAT	REFFIBRE	E-HUB
LABOHR	MINERALS4EU	NOVACAM
ERUDESP	CAMINEMS	STREAMER
MUST	MULTILAYER	MUJULIMA
ARTIVASC 3D	NMP TEAM	TRANS-IND
HARWIN	THEBARCODE	MARINA
NANORUCER	INDUSTRYTECH2014	LIFELONGJOINTS
CLAFIS	NANOINDENT-PLUS	REMANENCE
COMPOLIGHT	ALIGHT	RESSEEPE
NANOCOOL	LANIR	RESTORATION
ECOGEL CRONOS	NANOCHANNELS	SANS
MULTIFUN	NHECD	FLEXINET
LISSEN	HARCO	GRAFOL

Appendix C Final sampling

CAMINEMS	OPTICO (instead of REFFIBRE)	HARWIN
NANOMMUNE	SWARMITFIX	NANOCOOL
TRANS-INT (instead of CASCATBEL)	F^3 FACTORY (instead of MULTILAYER)	EASEE (instead of TRIBUTE)
MARINA	TRANS-IND	STREAMER
LANIR	TRANSPARENCY (instead of CLAFIS)	RESSEEPE
NANO-DETECTOR	COMPOLIGHT	PHOCAM
NANO-CHANNELS	NOVACAM	HARCO
observatoryNANO (instead of NANORUCER, led by Fr. ISI)	ROMEO (instead of MUJULIMA)	HI-MICRO (instead of ECOGEL CRONOS)
NHECD	MUST	FLEXINET
ERUDESP	MULTIFUN	ENEPLAN
ALIGHT	BIOAGROTEX	GRAFOL
ARTIVASC 3D	REMANENCE	DIPLAT
LIFELONG-JOINTS	BUILDING UP (instead of MINERALS4EU)	FASHIONABLE
THEBARCODE	NMP TEAM	LABOHR
BUGWORKERS	ECNP-GROWTH	LISSEN
RESTORATION	NANOINDENT-PLUS	GREENLION
TAGS	E-HUB	NANOCHARM

Appendix D Case study template

1. Basic characteristics of the project (*sources: mostly database and desk research*)	
Sub questions	***Answers***
1.1 Project Coordinator: name of organisation, type of organisation, country	
1.2 Number of partners	
1.3 Composition of the project team: types of actors, sectors, countries, scientific disciplines *[see database for types of actors leading and dominating individual consortia]*	
1.4 Theme: N, M, P, I, PPP (Green Car, Factories of the Future, Energy Efficient Buildings)	
1.5 Action line text	
1.6 Call text	
1.7 Sub funding scheme	
1.8 Total project budget	
1.9 EC contribution	
1.10 Organisations that provided the matching fund for the project *[interviews]*	
1.11 TRL at the start of the project *[to be validated during the interviews]*	
1.12 Summary of the project	
2. Objectives and relevance	
2.1 What are the objectives of the project? *[mainly desk research, validated in interviews]*	*Illustration of the reporting approach:* *- Desk research indicated that the three strategic objectives of the project are [...] This is translated into 10 specific objectives that are addressed in the following 5 work packages [...]* *- Interviewee 1 emphasised objective X [...]* *- Interviewee 2 considered objective Y to be the main objective of the project [...]* *- Interviewee 3 listed all 10 objectives of the project and stressed the relation between these objectives [...]*
2.2 Which scientific, industrial and societal challenges are addressed by the project? *[desk research and interview]*	

2.3 What is the motivation for participation, from the perspective of individual participants? *[interview: this is a more direct way of asking about the relevance of a project, and possible valorisation/commercialisation]*	
3. Output	
3.1 Brief summary of output, such as publications, patents, prototypes, demonstrators and networking events. *[desk research]*	
3.2 What are the main examples of project output? *[open question in the interviews, to identify the output that is considered most important]*	
3.3 Compared to the project objectives, how did the project overachieve or underachieve in delivering output, and what were/are the main barriers and enablers? *[interview]*	
4. Scientific and technological impact	
4.1 Brief summary of S&T impact such as contributions to research infrastructures/ instrumentation, standards and S&T breakthroughs (within and between academic disciplines and technology fields) and new projects based on the output of this project. *[desk research]*	
4.2 What are the main examples of S&T impact, and which S&T impact do you expect, within how many years? *[open question in the interviews, to identify the S&T impact that is considered most important]*	
4.3 What are/will be the main barriers and enablers for achieving S&T impact, during and after the project? *[interview]*	
Question 4: different emphasis depending on the characteristics of the project and interviewee - Universities and other research organisations: the case study researcher should spend extra time on S&T impact (e.g. by asking interviewees for concrete examples of S&T impact, get the details). - Projects with TRL level 1-2 and/or 3-4: same point. - N-M-P-I: check for S&T impact that is referred to in the action line and call. - PPP Green Car: check for S&T impact that is referred to in the action line and call, and/or related to internal combustion engines, electric and hybrid vehicles, logistics and co-	

modality. *[see KPIs, although they are rather abstract]* - PPP Factories of the Future: check for S&T impact that is referred to in the action line and call, and/or related to sustainable, ICT-enabled and high performance manufacturing, and exploiting new materials in manufacturing. *[see KPIs]* - PPP Energy Efficient Buildings: check for S&T impact that is referred to in the action line and call, and/or related to new design and manufacturing ICT for resource efficiency, improvements at district level, and key demonstration topics. *[see KPIs]*	
5. Economic impact	
5.1 Brief summary of economic impact such as new or substantially improved products/services/processes, value chains, spinoffs and new firms, and research infrastructures/instrumentation and how this leads to cost savings, increased productivity, competitiveness, employment and revenue growth. *[desk research]*	
5.2 What are the main examples of economic impact and which economic impact do you expect, within how many years? *[open question in the interviews, to identify the economic impact that is considered most important]*	
5.3 What are/will be the main barriers and enablers for achieving economic impact, during and after the project? Which role did the ESIC services play? How and to which extent did they help to identify (and exploit) the economic potential of your project? *[interview]*	
5.4 How did the consortium disseminate the results of the project to a larger group of companies, and did this already had any economic impact? *[desk research and interview]*	
Question 5: different emphasis depending on the characteristics of the project and interviewee - Universities and other research organisations: use the interview to ask whether the project leads to additional contract research, revenues from patent licensing and (when relevant) revenues from research infrastructures/instruments. - Industry: the case study researcher should spend extra time on economic impact (e.g. by asking interviewees for concrete examples of economic impact, get the details). - Projects with TRL level 5-6 and 7+: same point. - N-M-P-I: check for economic impact that is referred to in the action line and call. - PPP Green Car: check for economic impact that is referred to in the action line and call, and/or that is related to engine manufacturers and the car industry. *[see KPIs, although they are rather abstract]* - PPP Factories of the Future: check for economic impact that is referred to in the action line and call, and/or that is related to manufacturing and ICT industries. *[see KPIs]*	

- PPP Energy Efficient Buildings: check for economic impact that is referred to in the action line and call, and/or that is related to construction/renovation industries, suppliers of materials and other firms that contribute to Energy Efficient Buildings *[see KPIs]*	
6. Societal impact (social and environmental impact)	
6.1 Brief summary of societal impact (*such as the development of energy efficient products, services and processes, the development of research infrastructures/ instruments/tools for supporting sustainable development, health innovation, and impact on policy making and inclusion)* *[desk research]*	
6.2 What are the main examples of societal impact of the project, and which societal impact do you expect, within how many years? *[open question in the interviews, to identify the societal impact that is considered most important]*	
6.3 What are the main barriers and enablers for achieving societal impact, during and after the project? *[interview]*	
6.4 How did the consortium disseminate the results of the project to a broader group of stakeholders that are relevant for achieving societal impact, and did this already had any societal impact? *[desk research and interview]*	
Question 6: Different emphasis depending on the characteristics of the project and interviewee - Downstream users, public organisations, associations: the case study researcher should spend extra time on societal impact (e.g. by asking interviewees for concrete examples of societal impact, get the details). - Projects with TRL level 5-6 and 7+: same point. - N-M-P-I: check for societal impact that is referred to in the action line and call (e.g. safety and health in N, resource efficiency in M, energy efficiency in P and I). - PPP Green Car: check for societal impact that is referred to in the action line and call, and/or that is related to renewable and non-polluting energy sources, safety and traffic fluidity. *[see KPIs, although they are rather abstract]* - PPP Factories of the Future: check for societal impact that is referred to in the action line and call, and/or that is related to sustainable manufacturing. *[see KPIs]* - PPP Energy Efficient Buildings: to check for societal impact that is referred to in the action line and call, and/or that is related to resource efficiency, CO_2 emission and long lasting quality of buildings. *[see KPIs]*	
7. Impact on social networks and the European Research Area	
7.1 Who took the initiative for the project? *[interview]*	

7.2 How does the project and consortium build on previous projects and consortia? *[desk research and interview]*	
7.3 What are examples of new collaborations during the project? *[interview: ask for names of organisations, to identify new collaborations between:* - *SMEs and research organisations* - *Large firms and research organisations* - *Actors from different academic disciplines* - *Actors from different industrial sectors* - *Actors from different countries inside and outside the EU]*	
7.4 Which of these collaborations will continue after the project? *[interview]*	
7.5 Which consortium partners are most relevant for valorisation/ commercialisation of project results? *[if needed, ask specifically about large firms, SMEs, RTOs, downstream users, public organisations, etc. The answer to this question can be used to identify the 2nd or 3rd interviewee per project, and we may identify design flaws in the consortium]*	
7.6 How did the consortium function in terms of collaboration between different types of actors from different countries, dealing with project changes, consortium changes, etc? *[interview, optional. Only if time allows us to use this question to better understand the consortium, as this may explain some of the answers to other questions]*	
Question 7: Different emphasis depending on the project characteristics - Large consortia (10+ participants): the case study researcher should spend extra time on new collaborations (e.g. by asking interviewees for several concrete examples). - PPPs: same point. - New collaborations are also of special relevance for projects that are supported by one of the following funding sub schemes: CP-FP-SIC and CP-SICA for collaboration between actors from different countries (from inside and outside EU); CP-IP and CSA for collaboration between different types of actors.	
8. European added value (*all have source: interview*)	
8.1 To what extent does this European project builds on or has synergies with research and innovation projects that are funded by national or regional programmes? Which programmes?	

8.2 To what extent does the project build on (or have synergies with) research and innovation projects that are funded by companies? Which projects?	
8.3 For which output and impact (as discussed) was FP7-NMP funding most crucial?	
8.4 Would the project have been carried out (differently) without EU funding? *[note that in some countries national governments do not fund projects that can be funded at EU level]*	
8.5 To what extent does the FP7 NMP programme fill gaps that national and regional programmes leave open? *[if needed to clarify the question, ask for gaps in terms of specific topics, collaboration and funding]*	
8.6 How do you assess the effectiveness of the (sub) funding scheme via which the EU supported the project? *[optional and only for the Project Coordinator, if he/she has experience with different sub funding schemes]*	
8.7 Did (or will) the project lead to European Added Value in terms of critical mass (e.g. the level of public funding, triggering private funding, sharing knowledge, data and research facilities), reducing risks (technical or commercial, e.g. via standardization), mobility of researchers, and better coordination of national policies? *[some of these EAV examples may haven been mentioned in response to the previous question, so in 8.7 we double-check]*	
8.8 To what extent could the EAV of this specific FP7 project also have been achieved by means of other EU level or national programmes? *[optional, if question 8.5 did not lead to a clear answer]*	
9. Administrative procedures (*all source: interview)*	
9.1 Which specific administrative processes used by the European Commission in this FP7 NMP programme can be improved or made more efficient? In what way?	
9.2 How could the communication process between the EC and the consortium be improved? Please specify.	
9.3 Do you see any opportunities for	

increasing the efficiency of collaborative research projects in European Framework programmes? *[if needed, clarify the question by referring to cost reductions, the use of ICT tools, the optimal size of consortia and specific types of R&D&I that can be done more efficiently at national and regional level]*	
10. Closing questions (interview)	
10.1 Are there any other points you would like to raise that you think is important for the evaluation of the FP7 NMP programme?	
10.2 Based on your experience in this project, what are your main recommendations for Horizon 2020?	
Summary and reflection by the case study researcher	
Based on the information in the database and obtained via desk research and interviews, what are the main observations by the case study researcher? Take into account the answers to each of the 10 questions, and any links between the answers to individual questions. Take into account any consensus between interviewees (or the lack thereof) and any differences and similarities between information obtained via desk research and interviews. Assess the project in qualitative terms, e.g. how successful the project was in achieving output and imp Identify any potential best practices.	