The Impact of Horizon 2020
on European Research and Innovation

- Case study of FLSmidth

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Abstract

This paper examines Horizon 2020's ability to solve key challenges facing the EU, and how it can help to improve research and innovation at FLSmidth. A macro and micro level approach is used, where the EU related issues are presented in the macro sections and FLSmidth related issues in the micro sections. Both are combined at the end.

The key external and internal challenges facing the EU are presented and analysed, to see why the institutional logic in the EU's research and innovation policy has shifted. The research and innovation related challenges facing FLSmidth are also presented and analysed.

Guided by a conceptual framework, key factors and relationships were identified and studied in order to understand the field of research. This paper has applied the qualitative method in the form of six semi-structured interviews of key employees in FLSmidth, to get their input on the challenges facing FLSmidth. The interviews attempt to highlight how people in different parts of FLSmidth see the research and innovation related challenges, and if they believe open innovation and public funding can help address these challenges.

Among key findings, FLSmidth relies primarily on closed innovation, but has collaborated with universities and takes part in industry associations. The paper looks at the impact of these collaborations, the EU's aim of increasing industry participation in Horizon 2020, and gives recommendations for the EU and FLSmidth, on how Horizon 2020 can best address their challenges.

Table of Contents

1. Introduction

Research and innovation are high-lighted by the European Commission (EC) as a necessity for the future well-being of Europe. Technological progress by R&D and innovation is crucial for sustained growth and long-term competitiveness. For this reason public funding for business related R&D is justified in otherwise free economies.

Europe's prosperity depends on creating and maintaining world-class R&D. To ensure a vibrant knowledge economy, the European Union (EU) has presented the Horizon 2020 framework programme, which will enable universities and firms to undertake cutting-edge research, and increase competitiveness in the face of internal and external challenges. Horizon 2020 has three pillars: excellent science, industrial leadership and societal challenges. It opens up many new possibilities for firms and universities to collaborate and improve R&D and innovation.

In a highly competitive global market, firms must innovate and develop new products and services faster than ever before. To meet these challenges, firms have to embrace new approaches and collaborate with external partners across borders, and when necessary take advantage of public funding opportunities. The rising cost of R&D, makes it increasingly difficult for companies to remain competitive based solely on internal R&D efforts and funding.

This paper will look at the possibilities and challenges for FLSmidth in accessing public funding for research and innovation from the EU. Issues related to research and innovation collaboration with external partners based on public funding, will also be analysed.

Relevant literature and a conceptual framework will be presented to understand Horizon 2020 and the challenges facing the EU and FLSmidth. The literature will be discussed, and related to the case of FLSmidth as a European Firm leading in its industry, and with no previous access to EU funding. The role firms like FLSmidth can play in maintaining the EU as a leading research destination, and the benefits these firms can gain by participating in EU funded collaborations, will be discussed. A set of recommendations will be presented at the end of this paper for both the EU and FLSmidth. This paper will attempt to address the following research questions:

Research Question 1: How can Horizon 2020 tackle the challenges facing the EU by increasing the role of firms in the research and innovation process?

Research Question 2: How can FLSmidth utilize Horizon 2020 to enhance the research and innovation capability?

The following sections of this paper will be divided in macro level and micro level. The macro level sections will address the EU and Horizon 2020 focussing on the first research question, while the micro level sections will address the second research question regarding FLSmidth. This approach was chosen to be able to identify and analyse the distinct challenges present at both levels. The EU and FLSmidth face different challenges that need to be highlighted separately to better understand their distinct motivations.

This paper will attempt to highlight how the solutions to these challenges facing the EU and FLSmidth, are interconnected, in one benefitting the other. The EU's challenges cannot be solved without active involvement of firms like FLSmidth, and the challenges of FLSmidth require access to public funding programmes such as Horizon 2020. The successful implementation of Horizon 2020 is important for both. To maintain clarity throughout this paper, a micro and macro level distinction is necessary.

2. Methodology

A case-study (Flyvbjerg, 2006), is a detailed in-depth examination of a unit under study based on qualitative data. Case study research can be based on multiple sources of evidences, and for the purpose of this paper, semi-structured open-ended in-depth interviews have been used as the main tool. Qualitative data provide depth, and helps the researcher identify important categories, patterns and relationships in the interview data, which otherwise might not be visible. The semi-structured interview approach helps gather background knowledge, opinions, perceptions and attitudes (Harrell & Bradley, 2009). A researcher can use pre-prepared questions to initiate the interview, with the possibility of shifting from the order or inserting new questions during the interview, and tailoring certain questions for the individual respondent, to get in-depth information. (Saunders, Lewis, & Thornhill, 2007) This approach was used as the respondents had different roles in FLSmidth and different levels of experience and participation in collaborations.

The case-study can be used as a preliminary investigation of a more general occurrence. Context-dependent knowledge and experience play a key role in human affairs (Flyvbjerg, 2006). The close link between case-study and real-life situations gives access to a lot of information, which might otherwise not be accessible. To gain access to the greatest amount of information, the best approach is typically to locate an extreme or critical case, where the deeper causes can be found and analysed.

In this case-study FLSmidth has been selected to represent a critical case, being "least likely" to enter a Horizon 2020 collaboration, due to the following points. Firstly, FLSmidth is a large globalized company that does not view open-innovation as a strategic necessity and mainly practises closed innovation. Secondly, public funding plays a limited role in research and innovation in FLSmidth, and thirdly, despite being a global company, the collaboration is mainly focussed within the home country, Denmark. The social constructivist

paradigm will be used to understand how the participants view the issues and challenges facing FLSmidth and how Horizon 2020 can be utilized by FLSmidth. When working with qualitative data, the social constructivist paradigm is useful to study the social constructions in which actors and events unfold (Saunders, Lewis, & Thornhill, 2007).

Template analysis approach will be used to categorize and combine interview data, and analyse it to identify relevant themes, patterns and relationships. The template approach combines deductive and inductive approaches, as codes or categories are predetermined based on literature, and subsequently amended or inserted as data is collected and analysed during the research process (Saunders, Lewis, & Thornhill, 2007) (Waring & Wainwright, 2008). Template analysis's key advantage is flexibility as compared to the more rigid Grounded Theory approach, and ability to handle large amount of unstructured data.

A deductive approach has not been chosen for this paper as there has not been a combined study of such two actors' challenges and options, and mutual interdependence in such a setting. Horizon 2020 is a new framework programme, distinct from past programmes. This case-study is an exploratory study, to evaluate the possible effects of Horizon 2020 on firms like FLSmidth and their motivation for engaging in collaboration and open innovation. The literature examines the academic field of innovation, public funding, open innovation and institutional logics. As there is no theoretical framework to base this study on, a conceptual framework was developed to guide the research process and data analysis. The following section will explain the macro and micro-level information collecting process.

2.1 Macro level

Documents on Horizon 2020 prepared by the European Commission (EC) where studied. To understand the challenges facing the EU, reports by the EC on key challenges where studied, along with evaluation reports on previous framework. This data was used to understand the scenario in which Horizon 2020 was introduced, and what changes were made from previous programmes and why.

To get a broader view of Horizon 2020 and these challenges, I attended two conferences. The first conference was at Copenhagen Business School: "The Role of Social Science and Humanities in Horizon 2020". The second conference was arranged by the Danish Ministry of Science, Innovation and Higher Education: "Present day challenges – Future solutions, Conference on Horizon 2020". It was important to get input from these conferences, particularly from MEP's, committee members who were part of the Horizon 2020 formation process, and firms and universities who would be affected by it, on why things were done in a particular way, and also to get their views on the challenges facing the EU and Horizon 2020's ability to provide solutions.

The insight gained at these conferences, and interactions with other participants, helped form a cluster of background information, that was used to pinpoint the aspects of Horizon 2020 most relevant for this study and focus my attention on those.

2.2 Micro level

In-depth interviews provide valuable data regarding the participants' experience and understanding of a particular topic. The open-ended interview can go beyond providing a simple answer, to giving an insight into how the participants view the situations they are facing and how they construct reality (Creswell & Plano-Clark, 2007).

Qualitative interview design can take many forms, depending on the data needed and the research being conducted (Roulston, 2010). For the purpose of this paper, the format I used for the interview design was semi-structured open-ended interview. The open-ended interview with a semi-structured approach provided a structure in terms of wording of the questions, making it possible to ask similarly worded questions to respondents, and also provide room for expanding the questions with follow-ups to seek further clarification of a key issue or view on a topic.

The wordings of the questions were chosen as such that it enabled the participant to provide an open-ended response, and give me the opportunity to ask follow-up questions when needed. The aim was to explore and seek information that could give an in-depth look into how issues relevant for this analysis, are viewed by key FLSmidth staff at multiple levels within the organisation. The role of the participant in the organisation also played a part in the forming of the questions.

A semi-structured interview lacks the possibility of standardisation, which can be a problem for the reliability of the data (Harrell & Bradley, 2009). The interview data can be limited to a specific time and situational surroundings making it difficult to reproduce it in a different setting (Saunders, Lewis, & Thornhill, 2007). Validity is the extent to which a researcher can access the participant's knowledge, experience and is able to interpret it correctly per its intended meaning ibid. To increase validity of interview data, the participants were allowed to talk freely about issues to get in-depth knowledge, besides recording, notes were taken during the interviews to ensure situational data, gestures, body language, etc. were correctly recorded. Following the interview participants were shown transcripts of the interview for approval to ensure interpretation was correct. In some cases the interview data, was compared to other written sources. Some of the questions and the themes were standardised to increase reliability. To ensure validity of quotes used in the analysis, the transcripts are attached to this paper in the appendix section.

After a brief introduction, exploratory questions were asked to understand the background of the participant and role in the organisation. This continued into more in-depth questions, taking a closer look at a few key critical areas; innovation, collaboration, public funding, IPR and knowledge sharing. The concluding questions when time allowed, attempted to summarize the discussed issues, and reach a conclusion of sorts. The interviews were conducted over a period of two months. The answers from one interview influenced to some degree the questions for the next interview, to get more clarity and focus on key areas.

My research process started with a project proposal highlighting key topics I wanted to research. FLSmidth was chosen for the case study, due to their leading position in their industry and high level of globalization.

After initiating contact with FLSmidth a meeting was arranged with Kimmo Vesamäki, Senior Vice-President, and Thomas Hørup, Innovation Facilitator. During this meeting, the initial project proposal was discussed and we agreed on some modifications. Following the meeting I sent a modified proposal which was accepted. A meeting was arranged for signing of a confidentiality contract. During this meeting I met Hannibal Nielsen, Research Manager, Valby. He invited me for a briefing on FLSmidth, where I was given insight into the key business areas and the research and innovation process.

Before starting the Interviews, I gave a briefing to Hannibal Nielsen, Thomas Hørup and Ole Mogensen (Research Manager FLSmidth Dania), regarding my project and Horizon 2020. Following the briefing we discussed Horizon 2020, innovation and collaboration. These discussions and knowledge from previous interactions, was used in the formation of the interview guide. To improve my understanding of the company, the innovation strategy and collaboration practices, I was given limited access to some classified knowledge during my visits to FLSmidth.

After my formal interactions at FLSmidth, I was sometimes generously invited for lunch, and during lunch I got the opportunity to engage in informal discussions. These informal discussions provided valuable insight for this case study. The informal discussions and the confidential information is not a part of this paper, due to confidentiality agreement, but it has served as background information for the interview guides.

Initially three interviews were planned, one each at the strategic, managerial and operational level. The three interview participants were chosen with assistance from Thomas Hørup, on the basis of their ability to provide relevant key data. After conducting two interviews, I requested to interview people whose name came up during those interviews. I was given permission and a total of six interviews were conducted. The additional interviews provided valuable information, increased reliability and validity of the research data. There was on average 1-2 weeks between the interviews. That time was used to adjust the questions for the

next interview, based on the findings.

Of the six interviews conducted, five took place at FLSmidth headquarters in Valby, Copenhagen, in the offices of the participants. The final interview with Ole Mogensen was conducted in his office in FLSmidth research centre Dania, in Mariager, North Jutland. Following that interview I was given a tour of the very advanced and world-class research facility. Being able to visit the research centre, and see where research was conducted gave a valuable understanding of the process.

Level	Participant	Title	Location	Time
Strategic	Kimmo Vesamäki	Senior Vice President, Group Research & Product Review	Valby	1 ½ hour
Managerial	Hannibal Nielsen	Department Manager, Research Valby	Valby	1 ½ hour
Managerial	Lars Skaarup Jensen	Department Manager, Process Technology	Valby	½ hour
Operational	Klaus Hjuler	Research and Development Engineer	Valby	1 hour
Operational	Thomas Hørup	Innovation Facilitator	Valby	½ hour
Managerial	Ole Mogensen	General Manager, Research Centre Dania	Dania	1 ½ hour

List of Interviews (Table 1).

2.2 Delimitations

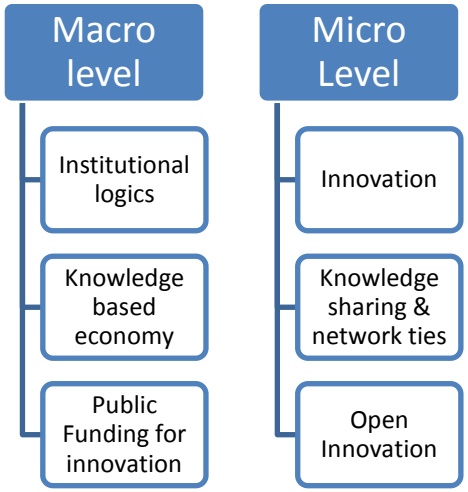
Due to the limited scope of a master thesis and a limited time frame available, aspects of Horizon 2020 relevant for this paper will be studied only. There will not be an in-depth analysis of the entire Horizon 2020 programme. Sections of Horizon 2020 not related to FLSmidth's key business areas and innovation strategy will not be analysed or looked into. Similarly the EU legislative process and the role of EU institutions will not be studied, as there is a lot of literature on that already and it's beyond the scope of this paper. The financial crisis of 2008 and the implication for EU member states, such as budgetary constraints, and its impact on firms like FLSmidth will also not be touched. As Horizon 2020 is a long term programme, therefore this paper focuses on long term challenges and not the short-term political issues that might have dominated EU politics at one particular time in the Horizon 2020 process. The aim is to make a study of the key long term challenges facing the EU which necessitated Horizon 2020, and how Horizon 2020 can benefit firms like FLSmidth. The research of this paper will seek to present recommendations at both EU level and for FLSmidth for future decision-making and policy making, therefore only data that is directly relevant will be analysed. Matters of finance, human resource management, FDI, etc. will not be mentioned. The concepts of innovation, knowledge economy, etc. cover a broad field, but for this paper only the aspects most relevant will be discussed.

3. Conceptual Framework

Conceptual framework is the system of concepts, theories, beliefs, models, etc. that provide support to the research being conducted. The conceptual framework explains the key factors, variables, and their relationship, which is to be studied. It helps the selection of relevant literature, theories and shapes the research (Maxwell, 2005).

This section is divided into two parts. The first part will take a macro level view, starting with institutional logic. This will help in understanding the events at macro-societal level, which affect institutional logic, in this case events at EU level which shaped Horizon 2020. This will be followed by a look at the concept of knowledge-based economy, and national systems of innovation perspective. Literature on the role of government, firms and academia in a knowledge-based economy will be presented, to understand how their interactions and complex relationships can affect the dynamics of a knowledge-based economy, and what factors can enhance innovativeness and competitive advantage.

The second part of this section will address micro level issues, innovation and firm's innovativeness. What challenges firms face regarding innovation and the importance of knowledge sharing. Open innovation as an approach for better innovation, and the role of collaboration with external partners, will be studied.



Overview of literature section (Figure 1)

3.1 Macro level literature review

To analyze complex multi-purpose multi-organizational policies, shaped by multi-level interactions involving a complicated net of actors, the institutional logics approach brings a set of suitable tools to analyze the socio-economic structures and their linkages. The EU framework programmes for R&D funding are complex multi-organizational with multi-level relationships trying to address challenges facing the EU as a whole.

3.1.1 Institutional logics

Friedland and Alford first introduced the term institutional logics. They defined institutional logics as a set of material practices and symbolic constructions, which establish the basic organizing principles. They argued that interests, identities, values, views and practices of organizations and individuals are embedded in institutional logics. (Thornton, Ocasio, & Lounsbury, 2012)

Friedland and Alford identified five important institutional orders in western society. The five were: capitalism, state, democracy, family and religion. The routines and rituals of each institution are linked. Some rituals define the order of the world and how the individual fits into it, while other rituals enhance belief in the institution. All five institutional orders are despite their conflictual nature interdependent, which creates uncertainty regarding the interpretation of a concrete routine or ritual.

In their work Friedland and Alfords key thinking was to conceptualize society as inter-institutional system of societal sectors, where each sector represents different sets of expectations for social relations and organizational behavior. The five key institutional sectors each have their own separate logic. When viewing society as inter-institutional, it allows multiple sources of heterogeneity to be observed and theorized, and to better understand the contradictions of logics of different institutional orders, and acknowledge that there are multiple sources of rationality. Ibid.

According to Friedland and Alford, many key struggles among individuals, groups or institutions, are linked to the relationship between the five institutions and to which institutional logic has superiority over the others when regulating a particular activity, and lastly to the applicability of the logic on what group of people. While Friedland and Alford focused on institutional logics at a societal level, others have expanded the concept and applied it to markets, industries, inter-organizational networks, etc. The sectors were expanded to include markets, corporations, professions, state, family and religion. ibid.

Organizations are influenced by the institutional environment around them, which sets the criteria for their behavior as actors in this setting. Organizations acknowledge these settings and conform to these logics in order to be accepted as a proper organization within this institutional framework. There can be multiple institutional logics available for an organization.

Thornton and Ocasio (2008) further elaborate and define institutional logics as; *the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organizations provide meaning to their daily activity, organize time and space, and reproduce their lives and experiences*. Ibid.

Literature has focused on the importance of diverging logics, and shifts in logic caused by one type of logic dominating others. A study by Thornton and Ocasio (1999), showed how changing from professional logic to market logic, brought a change in how executive succession was done in higher education publishing sector. Similarly other studies have pointed out the various combinations of logics and their effect on competition and cooperation. The increase in new practices was shaped by competing logics, which caused a variation in organizational behavior and practice. (Thornton & Ocasio, 2008)

There can also be historical shifts in how different logics are perceived or given importance. While societies in the past had a greater emphasis on family and religion, modern societies are in higher extent given prominence to state and corporate logics, while now there seems to be a shift in the direction of market logics. The broad reach of the institutional logics meta-theory, and its capacity to research across multiple levels of analysis, much broader than initially proposed by Alford and Friedland, gives flexibility for wide variety of mechanisms to be highlighted in research. Theoretical mechanisms can operate at diverse levels of analysis, then the main theory. Ibid.

Institutional logics guide the goals and aims that are to be followed in an area along with the methods of how to follow those goals and aims. It is shared logics created inside an organization and with interaction with others in its surroundings which dictate how that organization should handle challenges emanating from its operational environment. EU policy and EU framework programmes as Horizon 2020 are result of interaction between multiple stakeholders over a long period of time. Institutional logics determine the importance of issues and challenges that are to be considered for such programmes, and which solutions that should be applied on those challenges and issues. A change therefore at the underlying institutional logic at EU level, sends ripples across the entire chain, requiring all actors linked to that organization to change their behaviour and actions. For the purpose of this paper, the analysis will be at societal-level, looking at how changes in institutional logic at societal level affected the formation of Horizon 2020.

3.1.2 The Knowledge Economy

In the knowledge economy, there is a new thinking of how the role of state, firms and universities should be re-thought and re-shaped as integrated elements within the knowledge economy. The universities in particular have a new focus and envisioned role change as creators of knowledge essential for economic growth and prosperity. The institutional framework provided by Etzokowitz and Leydesdorff (1999), the triple helix model, consisting of state-industry-university nexus, described by the two researchers as with the ability to transcend past patterns of interaction and develop new configurations of institutional interaction.

The term 'knowledge-based economy' is based on an understanding that knowledge and technology play a key role in economic growth. The Organization for Economic Cooperation and Development (OECD, 1996), has defined a knowledge-based economy as an economy highly based on a commercialized role of knowledge and technology. Knowledge creation is significantly regarded as a critical factor in economic growth, and enabler of high-tech industries, and highly skilled labor force that can give a competitive advantage, facilitate growth in productivity and resource efficiency.

In the OECD terminology, different types of knowledge are important in a knowledge based economy. These are "know-what", "know why", "know how" and "know-who". (OECD, 1996) **Know-what:** Factual knowledge easily identified as information and segmented into smaller bits. **Know-why:** Scientific knowledge about the principles and laws of nature. This type of knowledge is found in specialized organizations like universities. To access this knowledge firms need ties with these organizations, by either recruiting labor from these organizations or by establishing joint activities such as collaborations, which can facilitate transfer of this kind of knowledge. **Know-how:** The skills or the competency to do something. Skilled workers operating complex machinery rely on their know-how. This type of knowledge is generally developed and maintained within the firm. Industrial networks are formed mainly with the purpose of sharing and combining elements of know-how. **Know-who:** The information about who has what knowledge and who knows what to do with the knowledge. It involves the formation of networks and special relationships with key experts.

The term "knowledge-based economy" was developed by Peter Drucker (Drucker, 1993), to highlight the need for an economic theory to look into the role of knowledge as an economic resource. In his view such a theory was needed to explain the present economy and economic growth, and how knowledge can enable sweeping growth and market dominance. He divided knowledge in three categories as per its use, first is continuing improvement to existing knowledge, second the continuous exploitation of already accessed knowledge and thirdly innovation, the creation of truly new knowledge.

Countries can spend similar amounts of their GDP on knowledge creation, but may not achieve similar results, while some countries are better at developing new knowledge, others are better at commercializing it, while some are weak at developing new knowledge, but excel in using existing knowledge more efficiently. As with other resources the productivity of knowledge, becomes a critical factor in understanding knowledge as an asset and improving the utilization of knowledge. (Drucker, 1993)

Alvin Toffler presented a similar view on the role of knowledge in the future economy, where it would attain greater prominence then land, labor and capital (Toffler, 1980). Knowledge, broadly defined as data, information, technology, etc. would reduce the need of other commodities/inputs to create wealth. For

those having access to the right kind of knowledge, would be able to use less, raw materials, energy, time and still be able to produce more.

Nonaka and Toyama in their work examined how firms are not just knowledge processing plants, but actively participate in not just solving problems, but create problems, define problems, and develop knowledge to help solve the problems, and then further improve that knowledge to be able to better solve the problems in the future. The firm thus becomes more than just a body that consumes knowledge, to a body that produces and expands knowledge due to its actions and interactions. (Nonaka & Toyama, 2003)

Powell and Snellman have documented based on patent data that a shift is emerging in advanced industrial nations from an economy based on natural resources and physical inputs to a knowledge-based economy. According to their study, during the past four decades there has been a significant growth in knowledge stocks and this growth is linked to the emergence of new industries, such as IT, bio-tech, among others. (Powell & Snellman, 2004)

While patent data might suggest that a shift is emerging towards a knowledge-based economy, it is still difficult to make a claim that society as a whole is changing towards something radically different from the past. According to Keith Smith, all economic activity is based on some form of knowledge. The Pal Eolithic society was knowledge-based, having extensive knowledge of animal behavior, pyro technology and mining. Similarly modern day tribal people have sophisticated environmental knowledge. In 19th century claims were being made that science and knowledge were playing a major part in the economy (Smith, 2002). It is therefore difficult to explain knowledge as a new addition to the economy. The difficulty in developing a definition of what constitutes a knowledge-based economy can be due to the different views on what knowledge is. Smith believes that viewing knowledge-based economy as something new, is mainly linked to the emergence of information technology, and the idea that knowledge is a product. Ibid.

OECD data studied by Smith shows that investment in physical assets is about two and half times higher than investment in knowledge (education spending, R&D spending, etc.) as percentage of GDP. But looking at the growth rate, knowledge related investment is growing faster than investment in physical assets in the US, the Nordic countries and France. In other countries like Italy, Japan, Australia, Germany and UK, among others, investment in physical assets was growing faster than knowledge related investment. So while some countries are increasingly shifting their investment towards knowledge related fields, others are still investing in physical assets, so the shift towards knowledge is not a general trend yet. Ibid.

Ian Brinkley while defining the knowledge-based economy, reached the conclusion that it is not radical shift from the past, or a continuation of the same old, but a soft discontinuation from the past (Brinkley, 2006).

The key challenge according to Brinkley remains the definition of knowledge-based economy, as per the current OECD definition, 40 percent of UK GDP is generated by knowledge intensive firms, having just over 40 percent of the workforce as knowledge workers. To get an accurate understanding of what knowledge-based economy is more research is definitely needed. For this paper the OECD definition of knowledge-based economy will be used, due to its more general acceptance than other definitions available.

3.1.3 National systems of innovation

Knowledge and technology play an important role in economies as shown in the previous section. The national innovation systems view is that the flow of technology and information among institutions, firms and individuals, is critical to the innovation process. A complex set of relationships among the actors in the system of a diverse nature, guide the innovation related information flows. From a policy-making perspective, understanding the national system of innovation is important in enhancing innovation and competitiveness. As any competitive advantage brings more rewards, government actions to enhance firm's innovative capacity and competitive advantage, becomes more important. (Archibugi & Michie, 1997)

The approach highlights that innovation is the result of complex variables such as economic, social, political and geographic, which can be local, national or global. It could also be integration of the variables at local, national or global level. Innovation related interaction can happen through market or non-market interaction. Knowledge transfer can occur without economic incentives, as individuals are able to learn and imitate. Information flows can involve both tangible and intangible assets. Ibid. Technological capabilities are viewed as national source of competitive advantage and therefore necessary for national level action to ensure that capability remains and is enhanced. Researchers share the view that national nation-specific factors play a critical role in forming technological developments. Historical factors also play a role, but the critical element is the interaction between the various participants in the national system of innovation. Ibid.

States can opt for either competition with other states to achieve competitive advantage, or use increased cooperation across borders to reach their aim. Innovation policies are therefore not solely national, and are shaped or influenced by external events and actions by rival nations. On the other hand, the firms that the state attempts to make more competitive, have an international outlook and while not being "stateless", their loyalty to home country is a matter of debate. Some argue that their competitive advantage is still linked to their home country. National governments and public institutions are expected to be accountable to the nation's citizens, while firms are accountable to somewhat stateless shareholders. Firm's activities in foreign countries, can also increase their affiliation with foreign governments, while decreasing their national linkages (ibid).

3.1.4 Public Funding

The uncertainty of innovation results, at times the high cost of undertaking innovation can make a difficult case for private investment. The benefits of innovation on society due to knowledge spill-overs create room for governments to fund innovation. Public funding can allow the undertaking of research that has no direct commercial aspects, and provide firms a basis for collaborating with external partners which otherwise might not be possible. Participating in publically funded collaborations can enhance the firm's ability to share knowledge with other firms and institutions, increase linkages between them, improve the firm's ability to identify potential partners and assess their reliability. Having obtained approval for public funding, can improve the firm's image among current and future investors and give a positive view of its technological capabilities. (Lee & Wong, 2009)

Participation in a publically funded collaboration could alleviate concerns of opportunistic behaviour by other firms in a collaborative setup, seen by some as major barrier to collaboration. The transaction costs associated with preventing opportunistic behaviour can be a reason for firms to opt out of collaborations. Ibid. The forming of contracts and agreeing on goals and aims of the collaboration, IP rights, financing, administration, dispute handling mechanisms, etc. during collaborations can be very challenging and costly. The contract negotiation can be costly and time consuming without any assurance of a beneficial outcome, as the parties can walk away any time. Even after signing a contract, dispute settling and enforcing the contract can be challenging.

A publically funded collaboration can to some extent ward off opportunistic behaviour and reduce transaction cost, due to the institutional settings within which such funds are released. Ibid. Governments by providing public funding also provide institutional mechanisms that reduce opportunistic behaviour and reduce transactions action costs that can be barriers for R&D collaboration. The risk reduction due to public funding can enable a wider segment of firm's participation in R&D collaboration instead of only firms that have access to financial and legal resources to handle disputes.

Academic literature has debated the role of public funding and its effect on private R&D funding. There is a difference of opinion on whether public funding for R&D has a positive effect or no effect on firms R&D funding. Recent literature has shown that public funding can have positive effects on firms R&D spending. (Albors-Garrigos & Barrera, 2011)

In some cases funded firms have higher R&D orientation, and in other cases funding gives firm's the opportunity to engage in R&D, which they otherwise would not have. An OECD report from 2006 has concluded that public funding for R&D has stimulated launching of more R&D projects. Other studies have

shown that for public funding to have positive effect on R&D and give beneficiary firms an advantage, the firm's needs in-house absorptive capacity. A study of Finnish firms, (Koski, 2008), shows that high tech firms with a history of networking, and conducting high quality research, are more likely to receive public funding. Ibid.

There is largely consensus in literature that public funding can be necessary for innovation. As large firms have better networking ability due to more resources available for R&D and stronger absorptive capacity, the funding given to large firms brings better results in innovation. Bigger firms are better positioned to take advantage of public funding, than smaller firms with limited resources and capabilities for accessing external knowledge. Ibid.

Literature also shows that public funding for research has somewhat limited or no effect on job creation. Funding for research activities targeted towards new markets, an area that's normally more risky as compared to investing in the existing market where the firm has knowledge of market conditions, shows a higher employment growth then other areas. Public funding for risky ventures, reduces the inherent risk of such undertakings, and provides a safety for firms, who can use the safety to engage in research which they otherwise would not have. When public funding is targeted towards new business areas, it creates new market opportunities and more jobs. (Koski, 2008)

3.1.5 Triple helix-model

Governments wanting to improve innovation and competitiveness need to understand the interaction of certain key actors. Etzkowitz and Leydesdorff presented a model that led to the development of the triple helix thesis. It is designed to handle the complexity in the interaction and coordination between the three factors; universities, firms and government. (Leydesdorff, 2010)

In the knowledge-based economy, knowledge is a key commodity that creates growth and prosperity. This requires creation of new knowledge and better use of existing knowledge in new ways. Scientists and researchers from both firms and universities, have to interact more to create new structures that will shape the future. The divided spheres where firms and academy worked separately, is renounced as a past and outdated method, and the emphasis is on the need for both to share knowledge and cooperate to use existing knowledge better and gain efficiency in generating new knowledge. (Leydesdorff, 2010) The national innovation system represents the "government", and is the third key factor in the triple helix. The triple helix can be used to view regional, national and international systems. A wide ranging innovative cooperation between multiple actors at the different levels, can give the best results with regards to innovation Ibid.

The model is constructed as a spiraling helix, where the three factors are independent of one another, but interact with each other at different level in different ways. The action of one affects the others, and through the actions and interactions, dynamic new relationships are created, which foster the growth of the whole system. Without the interactions between the three, the system will stagnate. A triple helix is not stable, and the constant competition between the three dynamic factors increases the complexity of the system, and gives it added layers of flexibility to avoid stagnation.

3.1.6 The role of universities in innovation

The triple helix model gives universities an equally important role in the innovation process. Governments often use universities as a launching pad for initiatives aimed at improving local knowledge base, innovative capabilities and competitiveness. The linkages between firms and universities are increasingly being narrowed to allow for a greater transfer of academic knowledge from universities to firms. Universities are a key foundation for a knowledge-based economy. As such they are seen as strategic assets that need to be utilized efficiently to ensure competitiveness at a national level. Understanding universities unique role in a knowledge-based economy, and subsequently viewing them as strategic assets, has not had a positive effect on their funding. In most OECD countries, universities funding since 1979 has been on a decline. This has in some cases pushed the universities towards enhancing their ties with firms (David C. Mowery, 2005).

To increase linkages with firms, the knowledge created by universities has to be suited for commercial use and have direct commercial application. This affects the outlook of researchers and students from purely academic research to research with commercial application, from science logic to market logics. For firms, this entails that researchers and graduates are aware of the need to commercialize their knowledge ibid. Similarly government focus on key societal challenges, and funding for research aimed at solving those challenges, can create an environment that fosters cooperation between universities and firms, making research relevant and with direct practical application. Ibid.

For example, the Danish wind energy sector has been a focal point in Danish policy of reducing dependence on fossil fuels and increasing the share of renewable energy in the national energy supply. During the 1980'ies and 1990'ies, the wind energy sector received a lot government funding, making Denmark a global leader in wind energy. Danish universities have played a key role in researching and developing technologies that have made it possible for the Danish wind energy sector to be globally competitive. By offering study programmes aimed at the wind energy sector, universities have given firms access to a skilled work force. Without the active role played by the government, universities and firms, the wind energy sector would not have been able to achieve its current position. (Megavind, 2007) (Energistyrelsen, 2011)

3.2 Micro level literature review

3.2.1 Innovation

Invention is the emergence of a new idea, product, material, service, process, etc. and the term innovation comprises the whole process from how the idea-seeking process started, from realizing the need for a new approach, then the invention itself, followed by a practical use of the invention, and then commercialization of the invention. (Fagerberg, 2005) While inventions can occur in many places, such as universities and laboratories, innovation mainly happens in firms. Ibid. To achieve successful innovation the firm needs to use all its available resources and skills, from production know-how to market knowledge, coupled with access to financial resources and distribution networks. This is what sets the inventor apart from the innovator or as the innovation theorist Schumpeter would describe it; “the entrepreneur”.

The role of the entrepreneur is significant in the process, as there is an inherent uncertainty in all innovation projects, coupled with the need for quick action before someone else does it. The time needed, when following a standard process of studying all available knowledge on the subject and then finding the ideal solution, was too much and the process had to be done faster. To fast track the process, an entrepreneurial person with vision and leadership was needed, to overcome the prevalent resistance to new ideas. Innovation is therefore a result of the struggle between entrepreneurs and social inertia. In his later works Schumpeter acknowledged the increasing role of large organizations, where innovations mainly involved teamwork (Fagerberg, 2005).

There can be significant time difference between invention and innovation. The factors necessary for making a successful innovation might not be present when the invention occurs (Fagerberg, 2005). The production methods can be too expensive, or the process could be environmentally hazardous thus impracticable per local legislation, and necessary resources for production hard to acquire. The invention could therefore require other inventions to make it commercially feasible. Innovation is a continuing process (Fagerberg, 2005) and not a well-defined, standardized operation that can be exactly pinpointed to a location or time of market entry. Inventions can change during the process and subsequently modified, or adapted to a different use than originally planned.

Uncertainty is a major challenge for innovation. For cutting edge innovations, it can be difficult for firms to realize where to begin, how to seek relevant knowledge, which options to asses and study, and finally what path to take. As a path is decided, firms seeking first mover advantage can find themselves in a situation where they realize that the path chosen might not be best suited for the innovation, but path-dependency can make it difficult to make a switch to a new more suitable path. It is important in the early stages to keep

options open and flexible to changes. Ibid.

In the early stages of innovation, it is also important to remain open to new ideas and possible solutions. As the process moves further, a better understanding emerges of the factors involved and more options and solutions present themselves. The multitude of possible combinations of the ideas and knowledge gathered can make the innovations more complex and sophisticated. The increased complexity of the innovation process increases the dependency on external sources. Ibid.

When engaging external sources for input to the innovation process, the firms must enhance their "absorptive capacity", otherwise due to the mind-set of "not invented here" syndrome, valuable external knowledge could be wasted (Dasgupta, Gupta, & A. Sahay, 2011). The more efficient the firm becomes in carrying out internal routines and processes, using cumulative and embedded knowledge, the more difficult it becomes for the firm to utilize external knowledge that significantly challenges the internal make-up of the firm's routines and processes (Fagerberg, 2005). Also pertinent to mention, firms that engage with trusted partners in stable networks, can also suffer from the same problems it faces internally such as path-dependency. Established networks can lead to a common view on the challenges facing them, leading to a "group-think". To improve innovativeness and keep more options available, it can be beneficial to engage other firms than the usual partners. Ibid.

New innovation can require large-scale investments to make the innovations fulfil their potential. For radical innovations it is important to keep in mind, that it may require great societal investments in either infrastructure or organization. Therefore to ensure success of its innovation, the firm might need to partner with other agents of change. For firms to be innovative and competitive in a fast-changing market is a major challenge. According to Schumpeter initially the innovative firm was one lead by an entrepreneur with an innovative drive, to seek new ways of tackling the challenges faced by the firm. Over the years he acknowledged the large corporation as the innovative firm. (Lazonick, 2006)

The large corporation according to the resource based view has resources that enable it to achieve an advantage over its competitors. The experience obtained by the firm over the years, can give the firm an insight into the opportunities presented by the market, which its competitors might not possess. The firm can utilize its existing capabilities and market know-how to take advantage of the new opportunities and ensure future growth. Ibid.

3.2.2 Innovation Networks

For a firm to access external knowledge and resources to enhance its internal capabilities can be a key challenge. Collaboration can be important for developing new ideas and inventions. Collaboration networks

are increasingly gaining importance in the innovation process. Some have pointed out the need to open the innovation process and seek external input to find better solutions faster. In high-tech fields, scientific and technological progress is developing rapidly, and multiple sources of knowledge make it increasingly difficult for firms to single-handedly solve complex problems and bring innovative solutions to the market. (Powell & Grodal, 2006)

Firms in high-tech sectors with access to diverse collaboration partners will get access to knowledge from sources located outside their industry and regional cluster. Using such partners for R&D collaboration will expose the firm to new ideas, and expand the firm's experiences with various technologies and methods, and learn the value of different competencies in the innovation process. Firms can use different collaboration models such as joint ventures, outsourcing, strategic alliances, etc. They can choose different partners from academia, customers, suppliers, governments, rivals, etc. They can develop multiple ties with the same partner, on different collaborations or increase cooperation at different levels on the same project. Multiple ties on many levels, can increase interactions among the partners, and give added exposure to each other's competencies and resources. Ibid.

Networking relationships can be based on formal strong ties and informal weak ties. Outsourcing, strategic alliances, public-private partnerships, and other such relationships will require formal contracts. Whereas participating in academic events, industry and trade associations or similar, can be based on informal ties (Powell & Grodal, 2006). Strong ties emerge due to close and regular interactions, whereas weak ties occur due to irregular and limited interactions. Strong ties are based on high level of commonality therefore strong ties mostly reinforces existing ideas. Weak ties are more critical in passing new and different ideas from unusual sources, bringing in views that are not homogenous. This can be compared to interpersonal relations, where a strong tie is a close friend and a weak tie can be seen as an acquaintance. In situation where new ideas and solutions are required to solve a complex problem, weak ties can be the medium which gives access to a different and un-thought of ideas.

Formal ties are more likely to have higher level of innovation, because in closely connected networks, complex knowledge can more easily be transferred between the parties. According to a Danish study of 548 firms, the impact of innovation collaboration depends a lot on the type of partner and previous collaboration efforts between the two parties (Drejer & Vinding, 2003). Prior engagements between the parties can help develop a higher level of trust and cognitive understanding. This requires time. The research concluded that collaborating with domestic partners led to higher positive innovative efforts, by utilizing strong local ties ibid. Similarly, a Norwegian study conducted over a ten year period, showed that strong ties between firms that are members of the same industrial association, also have positive effects on

innovation collaboration. In this case it was not the geographical location that created stronger ties but the close interaction due to membership of the same industrial association.

Other studies (Ahuja, 2000) have shown that both direct and indirect ties can help in collaborations and have a positive effect, but the impact was higher with formal direct ties then with informal ties. A reason for the higher benefits achieved through direct ties instead of indirect ties, is the fact that direct ties in a closely knit network provide a better basis for knowledge transfer, particularly in high-tech sectors dealing with complex knowledge (Hansen, 1999). Whether strong ties or weak ties are better for innovation, is debated in literature and as such difficult to point towards a clear frontrunner, some have therefore come to the conclusion that both types of ties are needed for successful knowledge sharing. (Verburg & Hoving, 2007)

For firms in the high tech sector to benefit from participation in technology intensive networks involving other firms with similar capabilities, it is important to enhance in-house capacity to be able to absorb the external knowledge. This requires a high-level of in-house capacity building and access to similar knowledge, as that accessed in the networks. According to Powell et al. (1996), “What can be learned is crucially affected by what is already known”. While collaborating with external partners to access knowledge, the firm must maintain a similar level of expertise in-house.

Interacting with others in networks enhances the firm’s ability over time to engage other firms in beneficial collaborations. With more experience the firm develops the ability to better pick partners and acquire centrality in the networks it participates in. This helps increase the diversity of partners in collaborations. As the firm increases participation in networks and with diverse partners it gains visibility and achieves a central position in the industry. The achievement of such a centrality can help the firm grow. Linking with external partners in innovation collaborations can facilitate innovation, while having a strong in-house research capability can attract competent and diverse partners, to further improve innovation efforts.

Informal ties present their own set of opportunities and challenges. Although their effects on innovation are not as direct as that of formal ties, informal ties can help in creating linkages that develop into partnerships over time. Trust is a critical factor in such groupings of individuals, where critical knowledge can be shared to get other perspectives on a particular problem. Professional ties through personal linkages or via professional associations can be starting point for informal exchange of knowledge. These flows are less managed and controlled as those in formal ties. Having strong and weak ties with formal and informal networks, more often signals that an individual is innovative, as compared to those with ties only to a homogenous network. Informal ties and maintaining weak ties can be good way of accessing diverse sources of knowledge, and when opportunity arises, these ties can be made formal. (Ruef, 2002)

3.2.3 Knowledge sharing in innovation networks

For any kind of ties with external partners to be fruitful, knowledge sharing is the key challenge. A distinction can be made between explicit knowledge and tacit knowledge. Explicit knowledge can be easily codified into manuals, blueprints, training guides, etc. and thus is easily transferable from one entity to another. Tacit knowledge is more complex and can be deeply embedded in the firm's processes, etc. making it very difficult to codify. Formal ties based on a strong and long-term partnership, will find it easier to conduct knowledge transfer, as compared to new and informal ties. The transfer of knowledge can be hindered by the type of knowledge being transferred and by the culture of the firms. Older alliances are better suited for sharing of complex knowledge. Over time the firms get a better understanding of each other's knowledge base and culture, and the frequency of interaction between the two parties can also increase the flow of knowledge, making it possible to exchange tacit knowledge along with explicit knowledge (Powell & Grodal, 2006).

The transfer of complex tacit knowledge can be an expensive undertaking, whereas explicit knowledge can be shared more easily. The expenses and effort required to transfer complex tacit knowledge, means that it is only a limited number of actors in the networks that would have the resources and required competence to be able to undertake such a process. Therefore depending on the knowledge, and the absorptive capacity of the firm, the undertaking can be either wasteful if the knowledge involved is easily codified and transferred, similarly if the tacit knowledge is complex and hard to codify, the competitive edge gained by possessing that knowledge makes it rewarding.

The strength of ties can determine the ability of organizations in a network to innovate and share knowledge. The strength of ties, can be measured by looking at the relationships overall duration, the frequency of collaboration and the intensity of collaboration. A long relationship with high frequency and intensity of collaborations, signals a strong relationship between the parties (Verburg & Hoving, 2007).

To get an understanding of the networking, and mechanisms that influence behaviour of networks, a framework developed by Brass, et al. (2004) will be used. It looks at network ties at inter-personal, inter-unit and inter-organisational level. Interpersonal networks rely on actor similarity defined on the basis of factors as education, occupation, sex, age, etc. which ease communication, promote trust and reciprocity. Personality can also play a part. Physical location and organisational structure also influence inter-personal networks. People, who are placed at the same location or due to work assignments or role in the firm work closely, develop stronger ties. Environmental factors like mergers and acquisitions, national culture, also have an impact. Interpersonal-networks can be used to get jobs, increase performance, secure promotions and get influence, etc. (Brass, Galaskiewicz, Greve, & Tsai, 2004)

Inter-unit networks can be based on formal ties based on work flow, resource exchange and personnel transfer, or informal ties based on personal links and friendships between members of different units. As the organization is made of many units, and the units provide the context in which inter-personal networks emerge, inter-unit ties are a crucial connecting link. Interpersonal ties play an important role in inter-unit ties, as key individuals such as managers can foster ties between the units based on their interpersonal ties. The functions of a unit, and its resources or lack thereof, can also influence the decision to network. If resources of the units are strategically linked, the likeliness of networking increases. More resourceful units create more linkages. Control mechanisms and centralization can limit the space for inter-unit ties. Ibid.

Inter-organizational ties are described as joint ventures, strategic alliances, consortia, etc. There are four motives for inter-organizational cooperation; acquire resources, reduce uncertainty, enhance legitimacy and attain collective goals. While early research focused on motives behind cooperation, subsequent research has focussed on the factors that facilitate cooperation, such as learning, trust, norms, equity and context. (Brass, Galaskiewicz, Greve, & Tsai, 2004) Firms that have learnt how to work with other organizations are more likely to create or join new and diverse networks, and gain a dominant position in those networks. By participating in networks, firms learn how to network and become better at it. This experience makes them more attractive network partners. Trust is also very important in inter-organizational networks. While ties may be created on the basis of interpersonal trust, success of a network depends on inter-organisational trust. Prior ties between the parties matter a lot, particularly in conditions of uncertainty. But over-emphasis on trust can lead to risk averseness and retaining network ties that have lost usefulness. Ibid.

Besides trust, reciprocity of norms also plays an important part in network relations, and adherence to the set norms can determine if a firm is a good partner or not. In some case the adherence to norms can play a more important role than formal contracts governing the collaboration. Inter-organizational ties are more likely if both partners are of similar status and power. Cultural, historical and institutional contexts can also play a significant part in the formation of inter-organizational networks. Government agencies and foundations can serve as “conveners”, facilitating the creation of networks. This becomes relevant in settings where organizations might not have a direct need to collaborate, and thus require a push or incentive for joining an inter-organizational network. (Brass, Galaskiewicz, Greve, & Tsai, 2004)

The firm’s internal R&D capabilities and its internal R&D budget, play a significant role in the firm’s ability to absorb knowledge from participation in alliances with other firms. Without having strong internal capabilities the firm, even if it is able to form alliances and formal or informal ties with others, will not be able to access and absorb complex tacit knowledge. Building strong internal capabilities is therefore a must, to be able to achieve success in knowledge sharing. Powell et al. (1996), (Cohen & Levinthal, 1990)

Although close relationships in networks are necessary to achieve high level of knowledge sharing, they can also have several issues of their own that are important to deal with. Over time as the networks and alliances become closer and increase the level of knowledge sharing, they can also easily stagnate. The high-level of tacit knowledge sharing, can make it difficult for new participants to enter the group, and the same partners involved in the same network can over time increase "group think". Knowledge circulates among the same group, and thus stagnating new thinking and new ideas. The strong relationship might have outlived its usefulness, but the cost of building that relationship could make it difficult to cut it off and seek new more useful relationships. The bonds that were necessary in the past to build strong ties and enable knowledge sharing, can become barriers that hamper the recognition of more useful new options.

3.2.4 Open innovation

The Schumpeterian view of innovation is that the entrepreneur, possessing some forms of valuable or rare resource, which is hard to copy, is the agent of innovation since he/she has that particular combination of key resources to unlock the innovation. But once that innovation has been unlocked, and others begin copying or attempting to bring similar/better inventions to the market, the entrepreneur will lose market share and the innovative edge. The open innovation approach refutes this by claiming that sharing ideas and knowledge brings an even superior way of generating value. (Torkkeli, Kock, & Salmi, 2009)

The term open innovation first described by Henry Chesbrough characterizes research and development as an open system where valuable ideas can come from inside or outside the company. Open innovation assumes that valuable knowledge is broadly distributed, and that any single firm regardless of its R&D capabilities is not singlehandedly capable of maintaining all that in house, and has to locate and connect to external sources of knowledge in the innovation process. It is the opposite of a traditional approach where it's the internal research activities that lead to internally designed and created products that are marketed. In the open innovation approach external ideas are given the same importance as those developed within in the company. Chesbrough defines open innovation as:

"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively." (Chesbrough, 2006)

In open innovation process the business model uses both internally and externally generated ideas to create value which is then obtained by internal mechanisms that are specially defined for that task. In open innovation the business model has a key role as both the source of value creation and value capture. By focussing on both, the firm can maintain its position in the value chain of the industry. The firm should also not treat spill-overs from industrial R&D as a cost of doing business, but actively seek to use that knowledge

to create additional value by expanding the business model. (Chesbrough, 2006)

On the issue of maximizing value, the open innovation approach uses a traditional economic model view of value creating, the only change being that the firm has access to more sources of knowledge. Accessing that knowledge would acquire an in-house absorptive capacity. Being able to absorb external knowledge will not in itself give a competitive advantage. For that to happen, the firm must be able to combine the external knowledge with internal knowledge, and use that combination to generate an innovation. This emphasizes that the firm's own resources still play a key role, and can give the firm a competitive edge over its rivals. (Torkkeli, Kock, & Salmi, 2009)

The open innovation approach is a two-way flow of knowledge. The firm can both gain external knowledge but also depart with internal knowledge that has been underutilized by making it available for external partners. Additional cash flows could be generated by selling knowledge. For the firm it is therefore necessary to analyse both flows. Ibid. There are different factors that decide if a firm will be willing to engage in open innovation. Internal and external factors play a key part in the decision.

Internal determinants include factors that are characteristics of a given firm like size, endowment of complementary assets or absorptive capacity. Also economies of scale and stocks of knowledge within the firm are primarily internal factors that we assumed to have an effect on the firm's openness. External factors, on the other hand, are related more to the firm's external environment. (Torkkeli, Kock, & Salmi, 2009)

According to Torkkeli et al. large firms with high levels of complementary assets will gain greater benefits from accessing external knowledge and that large firms are more likely to access external knowledge to complement their large existing assets base, and look to create new synergies. A stumbling block for many large firms in this regard can be the "not-invented-here (NIH)" syndrome, which can damper the acquisition and integration of external knowledge. For smaller firms the lack of sizeable complementary assets can diminish the desire to seek external knowledge, but the appeal of engaging a larger firm with those assets available, and in unison creating a foundation for greater commercial success can be a pull-factor.

From a strategy perspective, for large firms that have access to in-house absorptive capacity and complementary assets, and critical knowledge of how their current knowledge based assets are performing within the current business model and market penetration, they will have significant resources available to analyze how external knowledge could enhance their market position. They can seek exploitation of external knowledge opportunities based on their large internal knowledge base and absorptive capacity. This will also make them attractive to large number of partners who are interested in accessing this large

knowledge portfolio and complementary capacity. An exploitive search strategy can give large firms an advantage when searching for key knowledge to address technological challenges. Large firms can use their position in such circumstances to seek benefits such as IP rights, or licensing arrangements with the other parties involved. Smaller firms without a similar large knowledge base will not be able to similarly take advantage from an exploitative innovation strategy. (Torkkeli, Kock, & Salmi, 2009)

Determinant of Open Innovation	Key aspects
Complementary assets	Firms with large assets base are attractive network partners because they can offer high level of synergies for integration of external knowledge.
Scale and learning effects	Economies of scale and potential savings in R&D expenditure can be key determinants for engaging in open innovation.
Absorptive capacity	Firms that have a high level of absorptive capacity and access to external networks and skilled staff, tend to be more open.
Knowledge sharing	For successful innovation, reciprocal knowledge sharing is important. Knowledge exchanges can institutionalized in joint ventures or partnerships.
Exploitation vs. exploration	Following an exploitative strategy, firms access a large number of external actors to work on a specific problem. Following an explorative strategy, firms can connect with new partners to access new sources of knowledge.

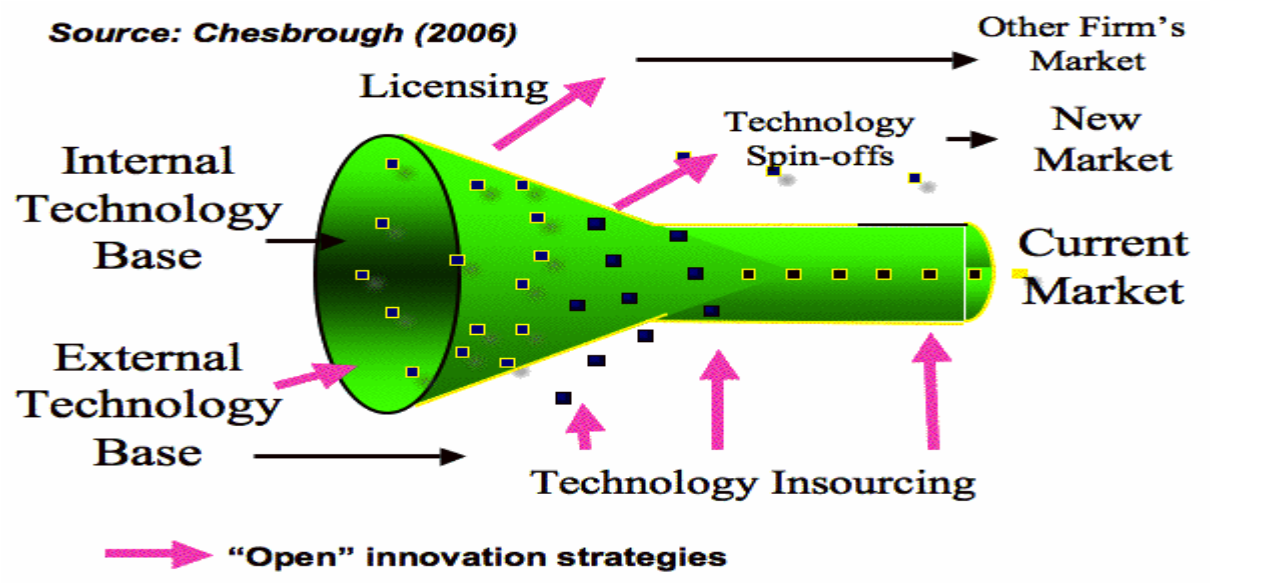
Open innovation key factors (table 2). (Torkkeli, Kock, & Salmi, 2009)

If the large firm chooses to adapt an exploration strategy instead of exploitation, then the benefits are less, because the firm will not be able to use its key in-house knowledge, but rely on broader indicators to explore with the aim of gaining un-expected new insights. Here the benefits for large and small firms are similar. This approach will also necessitate the involvement of new un-tested partners to again move from the known to the unknown knowledge clusters. Following such a strategy will require the firm to reduce redundant network activity and partnerships and engage new partners to access new ideas and sources of knowledge. While exploitation strategy can give more certainty and security in networking, exploration strategy gives less security in an unknown territory, but enhances access to new ideas and knowledge. Ibid.

The issue of Intellectual Property Rights (IPR) is viewed by Chesbrough as being important. Many firms maintain a large amount of patents which they see as an insurance against copying and expensive litigation, but many of these patents are not worth much in terms of value and are seldom used by the firm (Chesbrough, 2006). In the open innovation approach, IP is seen as assets that can bring additional revenue and new business opportunities. Firms should therefore actively sell and buy IP when a business opportunity arises. Failure to do so would be waste of resources and knowledge could be left unutilized.

While prior literature on innovation and the role of external knowledge highlighted more of a supporting role which external knowledge could play in the innovation process, the open innovation approach gives external knowledge an equal role instead of a supporting or supplementary role. As a departure from the past, where firms competed to hire the best and the brightest minds that would then be given funds and trusted to come up with valuable innovations, open innovation suggests that the business model should focus on both internal and external bright minds to come up with valuable innovations. Chesbrough suggests that innovations created by the firms should not be limited by the business model of the firm (Chesbrough, 2006). The current business model of the firm should not restrict the firm from cashing in on the innovation, and other opportunities to enter the market should be considered. The open innovation approach highlights that a project should not be classified as failure solely based on its inability to fit into the existing business model.

The knowledge that in the closed innovation process is termed as spill-over is in the open innovation approach regarded as an opportunity, where knowledge that internally lacked market-access capacity in its current form, can use an external route to market entry (Chesbrough, 2006). By opening up the external route for knowledge, competition can be created within the firm so that efforts to utilize that knowledge in-house are further enhanced. In the closed innovation process, knowledge is seen as hard to find, something that requires a lot of effort to un-earth. The open innovation approach sees knowledge as widely available requiring firms to keep a connection to external sources of knowledge, such as universities, start-ups, etc. (Chesbrough, 2006)



Open innovation model (figure 2).

IPR in open innovation is viewed as more than just a defensive tool against un-authorised copying and avoiding legal challenges. The open innovation approach suggests that IPR management should not be limited to this role, and there is a need to look beyond and locate opportunities where IP exchanges could be used to facilitate transfer of knowledge in the market. Finally the open innovation approach calls for new and different metrics to measure innovation. The evidence to support the open innovation approach is from mainly high-tech industries like computers, IT and pharmaceuticals based in the US. It is therefore to be seen how relevant open innovation is for other sectors of the high-tech industry, for those in the mid- to low tech and for those based outside the US. (Chesbrough, 2006)

In the following sections I will present the case of FLSmidth, and analyse how they view open innovation and collaboration. The concepts presented in this section will be applied to FLSmidth, to get an understanding of their approach to Innovation. Similarly the macro level concepts mentioned in the macro level, will be applied on the EU and it's challenges, along with Horizon 2020, will be analysed to get an understanding of the issues.

4. FLSmidth

FLSmidth is a global firm based in Denmark, with presence in over 50 countries and over 15,000 employees. The main business area of FLSmidth is in the cement and minerals industries, where it is a market leading supplier of equipment and services. FLSmidth provides everything from small units to complete cement and mineral plants. The cement division of the company is located in Denmark, and the minerals division is located in the US. FLSmidth has been a market leader in cement since 1882. The revenue of FLSmidth in 2012 was € 3.3 Billion, and 99% of that came from outside Denmark. (FLSmidth, 2013)

The main research facilities of FLSmidth having the responsibility of technology and innovation are located in Denmark and the US, with the offices in India providing a support function. The strength of FLSmidth lies in the strong brand, built over a century, and by having world class research and technology. Innovation is therefore valued very highly, and the company targets an investment of 2% of revenue annually in research and development, and a minimum of one new invention in each critical machines and processes every year. In 2012 the company invested 347 million DKK in R&D, accounting for 1.5% of revenue.

FLSmidth has recently launched a new growth strategy aiming at being full-service provider in the industry it serves, meaning that customers can get all their needs covered by FLSmidth. To achieve this goal, the company has singled out three areas where it has to focus to remain a strong player in the industry. These are; costumer intimacy - knowing the needs of the customers, product leadership – being a leader in technology and innovation, operational excellence – being highly efficient in execution. (FLSmidth, 2013)

On the FLSmidth website, Innovation is singled out as a key competence and the company values innovation leadership as a key tool in maintaining its position in the industry of more than a century. The FLSmidth Dania research centre in Jutland is the world's largest laboratory and test facility in the cement industry. R&D is highlighted as a top priority for the company. (FLSmidth)

Recently in august 2013 FLSmidth has had to lay off nearly 1,100 jobs due to lowered financial forecasts. Due to lowering of orders by several mining giants, FLSmidth has had to readjust its financial outlook for 2013, and expects similar lowered outlook in 2014. (Jensen, 2013)

Such events can have a strong effect on the innovation strategy, and can make it difficult to maintain the momentum and increase efforts. For firms like FLSmidth in such a position, maintaining leadership in the industry by having a strong R&D could require access to public funding. The involvement of external partners in R&D could help strengthening the process without the company needing to significantly increase its own R&D expenditure. It is in such circumstances that looking at collaborations and public funding options can be necessary for future growth.

5. New Cement Production Technology (NCPT) Platform

The NCPT platform was presented by FLSmidth for this case-study as a model for how FLSmidth has been working with external partners in publically funded collaborations. During my interviews all participants were asked about their role in the NCPT platform, to get their views on this collaboration and evaluate if the framework for this platform could be used in other collaborations.

The Advanced Technology Fund granted DKK 25 million for research collaboration between FLSmidth and DTU from 2007-2013, with the aim of improving competitiveness of Danish firms. The collaboration will enhance Danish firm's ability to increase their share of the global market in cement and minerals related technology (Højteknologifonden, 2007). Cement production is very energy-intensive, and releases approx. 5 % of global CO2 emissions. For FLS to remain competitive as a supplier to the cement industry, it is important to develop a more environmentally friendly way to produce cement. The NCPT platform aims to increase energy efficiency and reduce emission of hazardous materials. Close cooperation between FLSmidth and DTU, is necessary to achieve the desired results. (Højteknologifonden, 2007)

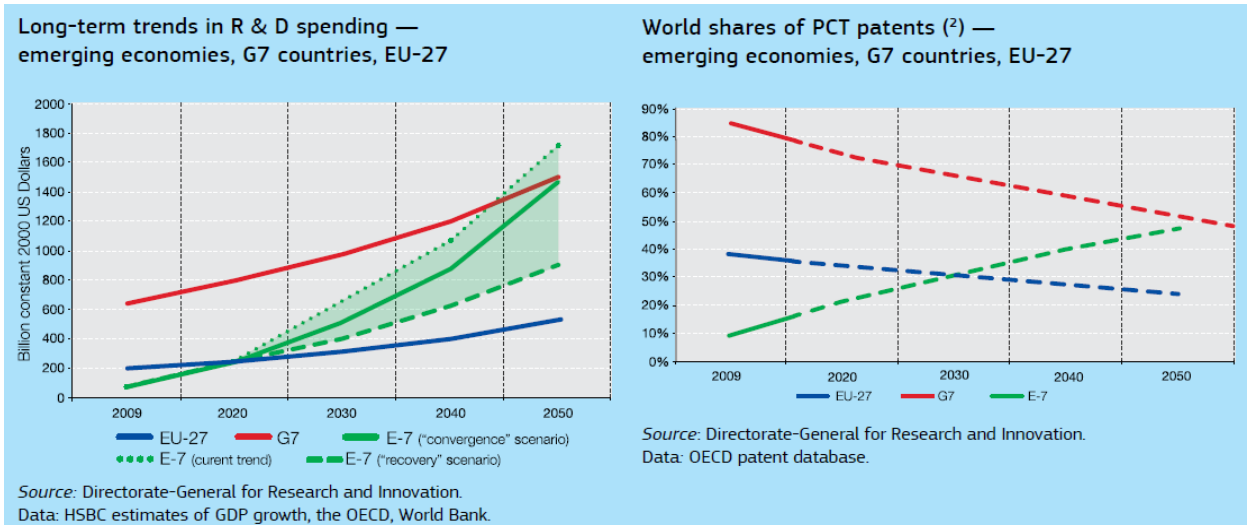
The aim of this collaboration is to get the research carried out in the 8 sub-projects in DTU's chemical engineering laboratories, tested in FLSmidth's R&D facilities in Valby and Mariager, moving the research from the laboratory and tested in an industrial setting. The research is carried out in PhD and Post Doc projects in FLSmidth and DTU, increasing the interaction between the employees of both organizations. Some of the PhD and post doc's have been hired by FLS. In the NCPT platform FLSmidth and DTU have discovered new ways to increase energy efficiency in cement plants and reduce emissions of hazardous materials. The success of this platform has led to a follow-up platform being established from 2014-2019. The Advanced Technology Fund has granted DKK 31 million in funding. A new industrial partner, Hempel A/S, an industrial paints producer has been added to the collaboration between FLSmidth and DTU. (Højteknologifonden, 2013) Hempel has expertise in the field of advanced paint and coating systems, which can increase the efficiency of cement and mineral plants by creating stronger surfaces that are resilient to wear and tear. The Advanced Technology Fund believes that by teaming Hempel up with FLSmidth and DTU, will give a boost to Danish R&D in both mineral and cement production.

6. Analysis – Macro level

6.1 Challenges facing the EU

The global economy is becoming increasingly competitive and new emerging economies are investing massively in education and R&D. The EU is facing many challenges from low growth, insufficient innovation, to environmental and social challenges. For the EU's future prosperity and the solution of these challenges, world class research and innovation is needed. The European Commission sees these challenges as linked, so that the solution of the environmental and social challenges will have a direct effect on enhancing productivity, generating long-term growth and securing the EU's position in the new world order. (European Commission, 2012) (European Commission, 2011)

The EU's spending on R&D is severely lagging behind other world leading economies, and it is expected that within the very near future, the R&D spending of the E-7 emerging economies[1] will also surpass the EU. Similarly the EU's share of global PCT patents is also declining. If this trend continues the EU will fail to generate cutting edge research, attract leading researchers and remain competitive. In areas where the EU has been leading in terms of research, there has not been a similar return in innovation. This is highlighted as the EU's innovation gap. To succeed in tackling the challenges, the EU must address the innovation gap issue, so that break-through research also translates into innovation. Ibid.



EU R&D funding compared to other nations. (figure3) (European Commission, 2012)

Public funding for top quality R&D can create significant long term benefits and increase economic growth. The European Commission (EC) believes that R&D is vital for industrial competitiveness and innovations have a positive effect on employment. For this to happen there must be a higher number of innovative

[1] Brazil, China, India, Indonesia, Mexico, Russia and Turkey.

firms in the high-tech sector, and the science base needs to strengthen. Cross-border links between researchers in the EU need to be improved, so that duplicate efforts can be controlled, and a more focussed EU level approach on key research areas developed. The member states failed to increase R&D funding when the economy was doing well, and are reluctant to do so now in a crisis. EU support for funding is therefore crucial according to the EU, as otherwise R&D would remain low, and key strategic focus areas not get the necessary attention. EU level support can utilize resources across member states and ensure better efficiency and less fragmentation. (European Commission, 2012)

For firms involvement in EU level R&D can give access to key industry players, reduce commercial risk, and opportunity to aid the development of standards and interoperable solutions. Studies have shown that EU funded projects have been strategically important for the participants. Some research areas would not have been considered feasible without external collaboration. While EU support is necessary for some research projects to even commence, it also enables other research programmes to be more ambitious and set higher targets. Many of the project proposals that do not get EU funding, are subsequently not carried out. Research that is carried out without EU funding, is significantly reduced and not fully able to achieve its strategic importance. Ibid.

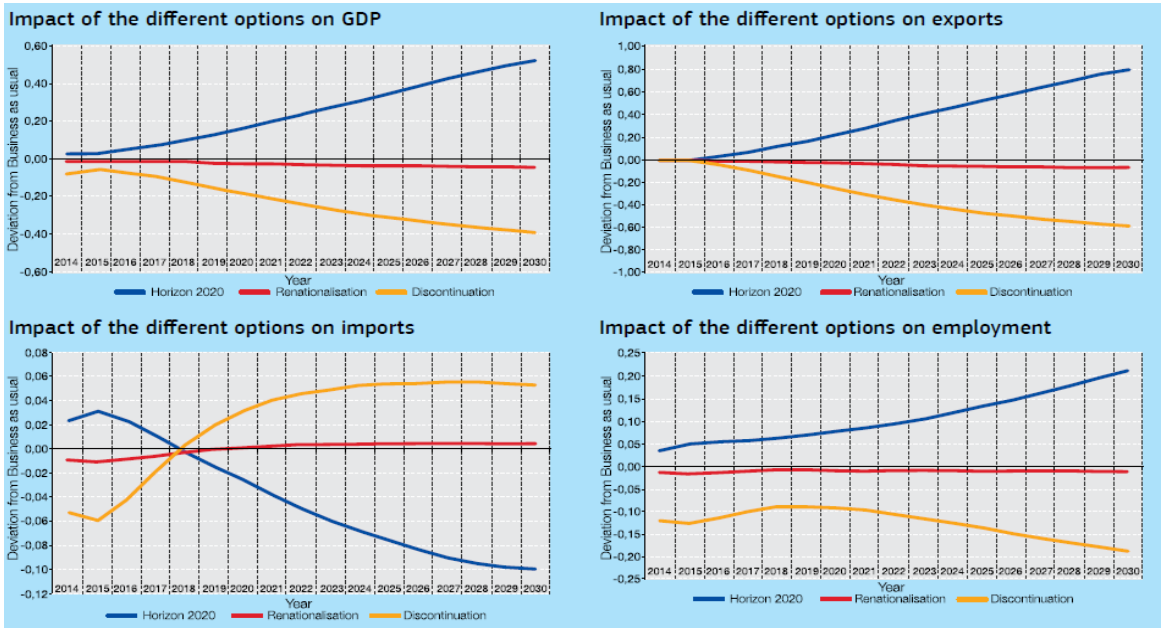
The EU has recognised this urgency, and aims to increase R&D funding to 3% of GDP by 2020, and refocusing policy and innovation on major challenges identified by the EU such as; climate change, energy and resource efficiency, health and demographic change. The approach also calls for better links between research and commercialization. The success of former EU framework programmes is also highlighted by the EU as a reason for them to take a bigger control of the Unions R&D policy and future course. Ibid.

The EU believes that this task cannot be left to the market alone, and therefore pushing significantly with policy and public funding to direct efforts in a direction the EU believes will be best suited for tackling these challenges. The EU is also not satisfied with the performance of the academic sector and its lack of ability in establishing links with business, which can help commercialize research created by the universities. The EU accepts the blame for some of the lacking's in the R&D coordination, as having different EU programmes that were not clearly defined and focussed on the solving of the strategic challenges. Ibid.

To address these challenges there needs to be efforts directed at strengthening the EU's science base, boosting industrial leadership and competitiveness, increasing the role of research and innovation in solving societal challenges. The EU has evaluated that this can be achieved by among other things; increasing the efficiency of EU funding by reducing administrative costs and simplifying rules, creating transnational research and innovation networks, supporting public-private partnerships, promoting cutting-edge research

and training for researchers, and increasing international cooperation with non-EU countries. Ibid.

Among the policy options available, the EC focussed its efforts on Horizon 2020, which emerged as the most suitable option for dealing with the challenges. Continuing with the previous framework programme structure, a rather fragmented approach was deemed in-efficient, and improving it by merging some of the programmes and instruments and leaving others, was also deemed as a less effective way of tackling the challenges. Renationalisation of the entire research and innovation policy and funding area was also not a workable option. Horizon 2020 with its combined approach provided the best policy framework for dealing with the challenges facing the EU.

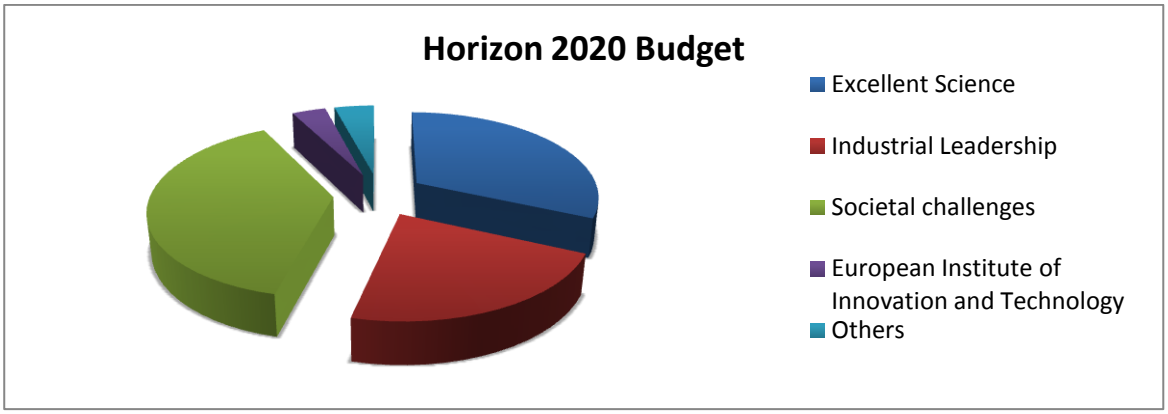


Impact of Horizon 2020 vs. other policy options (figure 4) (European Commission, 2012)

6.2 Horizon 2020 - A brief overview:

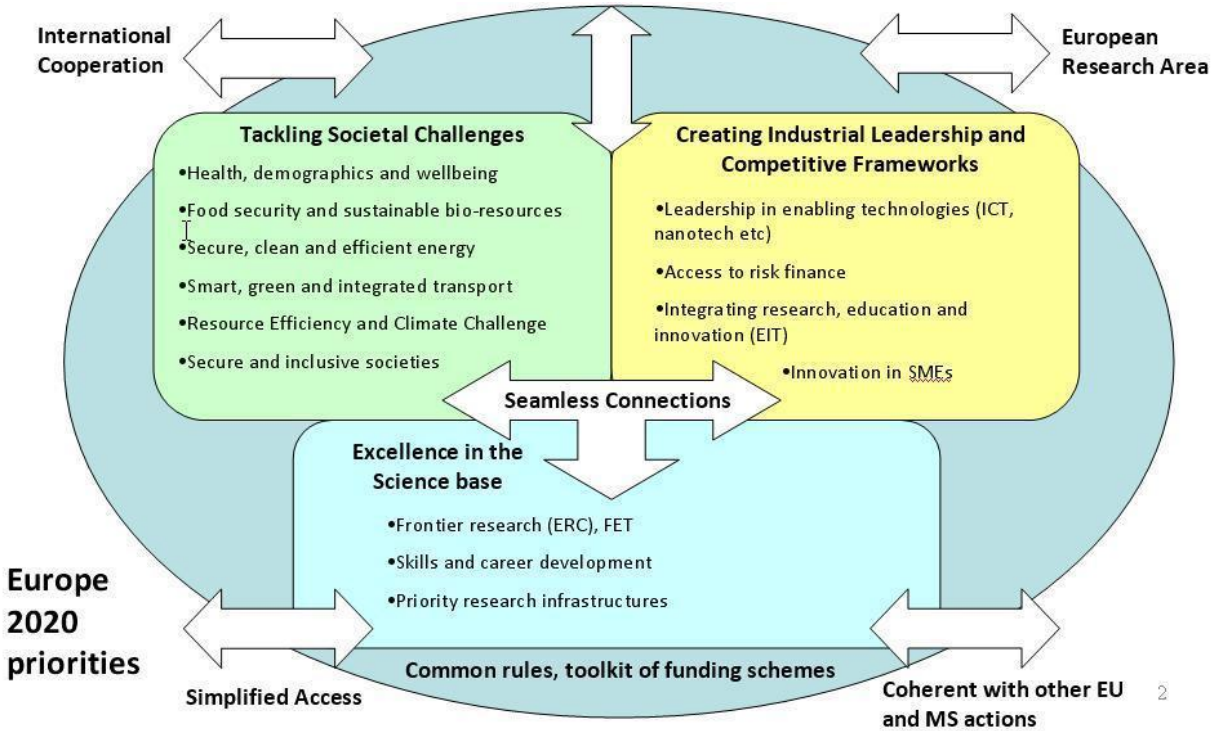
After long and drawn out deliberations, the final Horizon 2020 text and budget were passed by the European Council in October 2013. Horizon 2020 will begin from 1st January 2014, and replace the EU's 7th framework programme. Horizon 2020 will have a revised budget of €78.6 billion.

The budgetary allocations for the three pillars are fixed. Excellent Science will receive €24.4 billion, which equals to 31.7 % of the budget. Industrial Leadership will be getting €17 billion, which is about 22 %. Societal Challenges will receive the lion's share of €29.6 billion or about 38.5 %. Horizon 2020 will additionally provide funding for the European Institute of Innovation and Technology of €2.7 billion, and the Joint Research Council will receive €1.9 billion. Horizon 2020 will be complemented by the EURATOM programme, which has received funding of €1.6 billion.



Horizon 2020 Budget (figure 5) (European Commission, 2013)

Funds have also been allocated for "Spreading excellence and widening participation" € 816 million and "Science with and for society"€462 million. (European Commission, 2013) The aim of the Horizon 2020 is to strengthen the EU's strategy for growth and jobs, by providing funds for research and innovation, and facilitate the creation of the European Research Area where leading scientists and researchers, knowledge and technology can circulate across the EU.



Horizon 2020 overview (figure 6) (University College London)

Horizon 2020 consists of three pillars: Excellent Science, Industrial Leadership and Societal Challenges. The

aim of Excellent Science is to strengthen the EU's profile as a world leader in cutting edge science, enhance the EU's research and innovation credentials by making the EU more competitive. The aim of Industrial Leadership is to enhance the development of technologies that strengthen the industries in the EU, by supporting technologies that are close to market entry. Societal Challenges aims to tackle the challenges that the European societies are facing such as; health, food security, clean energy, green transport, climate change, secure and inclusive societies. These challenges are increasing, and in the coming years, will be a massive concern for governments all over Europe. It is therefore important that new technologies emerge which can help solve these challenges, and in the process create growth and new jobs. By strengthening the EU's green profile, a valuable competitive advantage can be gained, as these societal challenges will affect many other societies as well. Research in cost-effective solutions can help address these challenges in the EU, and provide a commodity for the export market. Similarly with Industrial Leadership and Science Excellence, the aim is to gain knowledge that can improve the EU's competitiveness, create jobs, increase growth and help tackle major societal challenges.

Horizon 2020 was seen as the best policy option due to it's focus on a smaller number of integrated and specific objective areas; higher growth and tackling of key sociatal challenges. It combines the research and innovation related parts of several EU programmes into one programme. Such unified approach was necessary in light of the large scale challenges facing the EU. The integrated approach of Horizon 2020 increases programme flexibility, promoting inter-disciplinary research and excellence. The aim is to satisfy all key stakeholders, by keeping the funding options less prescriptive and more open.

Administrative costs associated with applications for previous programmes have been a major complaint. Therefore continueing with a similar type of framework programme or improved version of it would not have lessened the bureaucratic hurdles significantly. According to the EC (European Commission, 2012) there was a need for a complete shift to a new programme, which could be designed fundamentally different and by merging different programmes into one, create a simplified entry point to EU funding. The aim of the EC is to reduce the complexity of proposal preparation and project participation by simplying the process and eliminating the need for submitting massive amounts of documents many times. The lower entry barriers can enhance accessability and attract more applicants and participants. Particularly there is a need to attract more industrial partners, and enhance links between industry and researchers. The flexibility in the Horizon 2020 programme is there to make it more appealing for industry, by showing openness to their needs. The dessemination of research and it's economic valorisation are areas the EC feels need more attention. Ibid.

EC data shows that participants of EU funded researh are more likely to collaborate and are more innovative

than those who do not. EC data also suggests that EU funding creates crowding-in effect, which attracts more funding for R&D. In some EU programmes for 1 Euro of EU funding, 4-5 Euro additional funding came form other sources. Nearly 2/3 of industry participants in EU programmes have been able to access more funding from other sources, in some studies a half of participants expect some sort of commercialization of research following their participation in a EU funded project. The commercialization aspect and demand from stakeholders has made the EU increase support for close to market projects, and provide funding for demonstrations, prototypes, etc. (European Commission, 2012)

	Framework Programme 7	HORIZON 2020
Focus	Research	Research and innovation
Budget	Approx. € 50 billion	€ 78.6 billion
Pillars	▪ Cooperation ▪ Ideas ▪ People ▪ Capacities ▪ EURATOM & JRC	▪ Excellent science ▪ Industrial leadership ▪ Societal challenges ▪ EURATOM & JRC
Funding rate for research	75 %	100 %
Funding rate for demonstrations	50 %	70 %
Process time	12 month in average	Within 8 month target.
International Cooperation	Supported.	Supported and seen as important.

Comparison between FP7 and Horizon 2020. Table 3. Ibid. (European Commission, 2007)

6.3 Analysis of Horizon 2020

Horizon 2020 marks a departure from past practises. Institutional logics, the guiding principles upon which social systems operate and interact, create the relationships between various actors in a society. The institutional logics and the actors that are part of it are not permanently fixed and subject to change, if and when various factors and events necessitate a change. The changes in Horizon 2020 as compared to previous framework programmes mark a significant change in institutional logics in EU R&D funding.

A framework programme such as Horizon 2020 is the product of a multi-year process involving different actors at EU level and national level. Institutional logic guides the behaviour and actions of the actors involved in process, as the institutional logics are the organizing principals behind institutionalized practices in systems such as the EU process.

The external challenges facing the EU, in the shape of research and innovation capacity of competing powers such as the US and Japan, the emerging powers Brazil, China, Russia, India, etc. who are massively

investing in R&D to improve their position in the global knowledge-based value chain, necessitate a response from the EU. Internal challenges facing EU countries, in the fields of health, climate, environment, growth, security, etc. also necessitate a response at EU level. The weaknesses of past EU framework programmes along with their lack of ability to adequately response to these new and increasing external and internal challenges, presents a need for a new approach to research and innovation.

This new approach to research and innovation has triggered a significant shift in the definition of the programmes and their aims. This shift has occurred due to the political pressure on the EU to provide a suitable response to the emerging challenges. The response to these challenges in the form of Horizon 2020, presents an altogether new approach to research and innovation in EU funding. This has been possible due to the change in the institutional logic which shaped the framing of EU research funding policy.

In the past decades the EU framework programmes for research funding, have been experiencing increases in funding each time. The last framework programme FP7 saw a significant surge in funding, and Horizon 2020 was expected to have a similar surge, but after many rounds of negotiations the final budget contained a more modest increase in funding than originally anticipated. Several factors were involved in this. The aims of Horizon 2020 and the goals the EU has set require a large amount of funding, but the financial problems in many EU member states, where many governments were facing down-sizing at home, made it difficult to secure a massive surge in funding for Horizon 2020. But the signal that Horizon 2020 as one of the few EU programmes which did not experience any downsizing, and perhaps the only one which experienced an increase, is important, and signals that research and innovation is a priority area.

Besides the emerging challenges facing the EU, performance of past framework programmes has also played a role in the shaping of Horizon 2020. The performance of FP7 and prior programmes, along with the input received from stakeholders, has influenced the structure of Horizon 2020 and its management by EU institutions. Half way into the FP7, a report by the EC evaluated the FP7 performance till that point in time, and used the findings to present recommendations for the next programme, Horizon 2020. In those recommendations, it was urged that innovation play a bigger role and industry should be drawn in more closely. (Expert Group Report EC, 2010)

The focus on innovation will need to be accommodated by a rebalancing of participation in favour of industry. In a proportionate way, FP8 will therefore have to reflect the pragmatic needs of researchers and companies and at the same time fulfil the (to be agreed) essential needs of those responsible for financial and legal oversight. (Expert Group Report EC, 2010) Page 77.

The above quote from the report shows the important shift that has taken place between FP7 and Horizon

2020. The conversion of scientific research into commercial application and solution of societal challenges was recommended in the FP7 evaluation report, which has subsequently been incorporated into Horizon 2020.

The EU process that led to the creation of Horizon 2020 from FP7 has shifted the EU research and innovation funding institutional logic from a scientific logic to market logic. The change in logic has been necessitated by the external and internal challenges facing the EU. The evaluations of FP7 and the analysis of the grand challenges facing the EU by the EC (European Commission, 2012) have called for more focus on innovation to address the key challenges. Increased involvement of industry is also seen as vital for enhancing innovation and achieving better commercialization of research.

The structure of Horizon 2020 seeks to incorporate broad based participation and seeks to attract new participants into EU framework programmes. The entry of new participants can bring a change in how the EU programmes work, and require a significant re-think in the EU of how to accommodate them into the process and the new ideas that emerge in process are adequately looked into to ensure that Horizon 2020 can fulfil its aims.

There can be areas where a systemic approach is necessary to ensure that research can be turned into a successful commercial product. Electric cars are one such area where universities, researchers or industry cannot by themselves ensure success. There are multiple issues related to electric cars, from their cost, refuelling, battery capacity, maintenance, etc. which require public funding into research in each area, coupled with industry-level business model re-drafting, and infrastructure support from member states to make them practical and a commercially viable product. Similarly there can be other areas particularly in climate, health or environmental technologies that cannot be a commercial success until there is a systemic approach towards that technology area.

The emerging of some previous programmes into one, Horizon 2020, shows that the new logic has introduced a need for alignment between different policy instruments to ensure that the aims of Horizon 2020 can be met. This signifies another shift from the past. The success of the new programme will be measured on its ability to provide actual solutions the internal societal challenges, and the external societal challenges, whereas in the past the success criteria were mainly creation of new knowledge and solutions. Now a commercial application of that knowledge and solution of key societal challenge has been added.

The commercial aspect, can serve as a motivation for industry to be involved in publically funded research. Having industry involved at an earlier stage in the process, could help in terms of early assessment of the commercial value of a particular research, thus reducing the use of resources on non-commercially viable

research. Fostering greater ties between industry and universities across boundaries of member states can have benefits of its own. Increased knowledge sharing can be beneficial for all parties participating in the process, and an EU level overview of all research and innovation funding programmes within the ambit of Horizon 2020 could reduce duplication of research efforts. That would prevent squandering of resources on identical projects in different countries.

The EU data on the possible benefits Horizon 2020 compared to previous framework programmes suggests that there are benefits for those firms who are able to get EU funding for their research projects. When considering the hurdles the EC feels were preventing a more accessable EU funding prior to Horizon 2020, the firms that were able to get funding prior to Horizon 2020, perhaps had significant resources available to them and intricate knowledge of EU processes to be able to get funding. Their level of innovativeness and patents application, etc. could be just a look at the research elite of Europe. It therefore remains to be seen if the figures on innovation, patents, commercialization, etc. remain the same with this new more accessible programme is activated possibly providing opportunity to firms and researcher that previously were not in a position to seek funding due to lack of resources or intricate knowledge of EU processes.

As a whole the EC expects the Horizon 2020 programme to improve the EU member nations GDP performance, competitiveness of firms, create jobs, alleviate social, health related and environmental challenges. A tall order for any framework programme. Key for Horizon 2020 will be if the improvements in Horizon 2020 over past programmes such as enhanced accessibility, more funding, more flexibility, etc. fail to materialize. Failure to coordinate effectively with member states programmes to reduce duplication could also be critical. In a complex policy making and governance structure such as the EU, and the length of the Horizon 2020 programme spanning over 7 years, necessitates that things go according to plan, otherwise the benefits expected with Horizon 2020 might not emerge and course correction may not be immediately possible.

Academic literature supports the position of the EC that public funding for research is beneficial. (Russell Group, 2012)Studies have shown that economic and social returns on public funding for R&D are high and in the EU's currents situation there is a need for a substantial investing in R&D to tackle the growing number of societal challenges and improving competitiveness.

Fundamental research for the advancement of knowledge that has long-term commercial aspects will typically not have adequate access to private funding. In addition to that, the high cost of undertaking such research, with high uncertainty attached to its findings and lack of market for its results make it a difficult proposal for the private sector to engage in. For fundamental research to be carried out, public funding is

important, as fundamental research can open new opportunities and provides inputs for radical innovations. It could also serve as an attraction for top researchers from around the world. Failure to maintain high level of Excellent Science research in Europe could cause significant damage to Europe's future potential as a leading R&D destination, as fundamental research is the building block of cutting edge science.

Horizon 2020 must be simplified and the administrative burden significantly lowered in order to attract the very best collaboration participants. Simplification and lower administrative burden for entry to Horizon 2020 could have far reaching consequences in terms of accessibility. This alone could attract more and better quality participants, and make it possible for SME's to also enter the fray. Without lowering the administrative burden and simplification of the process, having targets of X % SME involvement and attracting the very best, will remain unfulfilled as the cost of the process will be too expensive and cumbersome for many.

The participation of leading firms and top universities in Horizon 2020 is crucial for achieving growth, addressing societal challenges and enhancing Europe's global position. IPR is an important factor in collaboration, it is therefore critical that rules are clear and simple. There must be confidence in the rules for firms to engage in Horizon 2020 funded collaborations. It's also important that the rules are seen as fair to both the academic and business partners. The open access criteria should therefore be used flexibly and not enforced rigidly.

6.4 Knowledge-based economy

The overall aim of Horizon 2020 is to improve the EU's position as a leading knowledge-based economy. To reach these goal governments, universities and firms have to cooperate on a high level, as they are critical components of the triple-helix model. Generation of knowledge is the key focus of Horizon 2020, as the creation of new knowledge is what improves the competitiveness of a knowledge-based economy and solves some of the key societal challenges. To generate new knowledge collaboration between governments, universities and firms is crucial. Governments provide an institutional framework; universities are the primary source of knowledge and training of new researchers, while firms have market knowledge and the ability to commercialize knowledge into products and services.

Horizon 2020 attempts to strike a balance by providing much needed funds for R&D to universities and requiring greater role for industry in the process. Access to funds serves as a motivator for both, and the programme guidelines provide a foundation for collaboration within an institutional context. Horizon 2020 rightly aims at getting a strong and smooth connection between academia and business. But expecting a

higher level of commercialization solely based on this might not be accurate. Commercialisation is a complex process with many factors involved. It cannot be reduced to a linear process where knowledge is transferred from researchers to business and enters the market as a product. Once the initial linkages between universities and firms have been established, these can then develop dynamically as per the requirements of the situation and aims of the actors.

To ensure high level of innovation in the EU, dynamic and cross-sector ties (strong and weak), are important where transfer of both tacit and codified knowledge can take place. Simply transferring codified knowledge from researchers to firms in a manual will not be sufficient. Researchers must have an understanding of the circumstances under which firms are operating and the challenges they are facing regarding the commercialization of knowledge. While firms need an in-house absorptive capacity to be able to understand and utilize the knowledge produced by the researchers. More importantly, firms and universities must understand the importance of innovation and also need to show a willingness to engage with each other and share knowledge for mutual and societal benefits. Societal challenges, particularly environmental and climate research, and green technologies are an area where the EU is world leader (Appendix A, figure 1 and 2), and therefore that lead should be maintained by ensuring adequate funding for research and innovation. Similarly other areas where the EU has a competitive advantage should also be focussed on.

The EU can support the process by providing funding within a framework that caters to the needs of both. One area highlighted by both universities and firms as crucial, and also identified by EU evaluations, is the need for simplification of the framework programmes. Horizon 2020 has to large extent attempted to make the funding process simple. Reducing administrative burdens and handing out funds faster with fixed time frames, making the calls more flexible, will be hugely beneficial for the process. Having an open EU level playing field will enable large participation. This will also enable the EU to fund research projects that are world-class and fit the bill of excellence. By giving funding to excellent proposals, will increase the generation of new knowledge and improve competitiveness.

Fundamental research can have a significant impact on the economy because that is where new discoveries are made that can radically change how we do things. That’s why it is good that the excellence pillar has been given a large amount of funding in Horizon 2020. Reducing funding for fundamental research can cause long term damage to growth and jobs. It is important for universities to keep focussing on fundamental research and not neglect in favour of research areas with shorter time to market.

Firms should involve themselves in fundamental research, as working with universities in collaborations will

give them first-hand knowledge of upcoming technologies. This will give firms the possibility of first-mover advantage, when the technology matures. Horizon 2020 does focus on this by encouraging research in future and emerging technologies and it will be crucial that this focus is also kept in the upcoming calls and not shifted in favour of market logic and research with higher commercial aspects. Fundamental research is also an area where the EU has a competitive advantage over emerging economic powers, and to maintain this advantage fundamental research needs to be given priority.

In a challenging global context, a fact acknowledged in the Horizon 2020 formation process, there is a critical need for prioritising the growth of R&D and to be able to absorb new technologies. International cooperation with non EU members has been made possible in Horizon 2020, but for that to be beneficial, the internal capacity of EU firms and universities has to be at a level where they are able to absorb the new knowledge generated by the collaboration. To be able to absorb new knowledge, the EU has to push universities and firms in prioritizing cutting edge research, something Horizon 2020 does take into account. Prioritizing cutting edge research also increases the possibility of being first to come up with radical innovations that can create new markets or provide a significant competitive advantage in the current market.

Being the world's single largest market, with a large pool of leading universities conducting high level of research and producing leading researchers, as well as high number of publications, citations and patents (European Commission, 2012), gives the EU a unique global position in attracting new investment into R&D. The challenge for the EU is therefore to maintain that position by ensuring EU universities and firms have access to required funding, and directing that funding towards areas which give the EU a competitive advantage and simultaneously solve key societal challenges, under the Societal Challenges pillar, and enhancing the industrial competitiveness of EU firms under the Industrial Leadership pillar.

To attract world class researchers and maintain a top level of research quality, Horizon 2020 will need to ensure integration of the member states research and innovation policy, to promote the creation of world-class research, while universities, firms and governments of member states, will have to come together not just to collaborate on projects, but also on a larger scale to pool together resources and focus on key areas where a country or region has some advantage. By using this approach the different countries could specialize in key areas and utilize their resources in enhancing their capabilities in that area. For example the way Denmark has in wind energy and bio tech sector. This would also reduce duplication of efforts, and not have one area getting overrun with similar research conducted in multiple countries while other areas are neglected. Member countries that have national innovation programmes to supplement EU programmes will be in a better position to coordinate their efforts than those who do not. At the EU level

there will be a need to ensure some members states do not get left behind. Figure 1 (appendix A) shows the huge difference between EU countries in terms of employment in knowledge-intensive activities.

Industrial leadership pillar is important for providing funding for research into technologies that are closer to market. In the short and mid-term funding for such research can play a valuable part in solving the growth crises facing the EU, and provide support for key industrial technologies, and allow firms to take a leading role. Providing access to risk finance and funding for SME's are also welcome steps in improving R&D efforts in the union.

For firms like FLSmidth, IPR rules play a critical role when research is in technologies that are close to market. The rules and their administration must be clear and simple, as a lack of confidence in IPR rules could keep some firms from seeking EU funding. In Horizon 2020 the rules present overall a strengthening of the FP7 IPR rules. The participant which generates a result gets ownership of IP, and if there are multiple participants then joint ownership and protection as and when necessary. Results must be disseminated based on open access principle, and there are exploitation obligations in some research areas.

6.5 Part Summary

By enhancing the funding for research and innovation for Horizon 2020, the EU has shown that this is an important focus area. The increase in funds for research and innovation in a period of downsizing and financial restraint shows the importance given to Horizon 2020, and how vital a tool the EU sees it to address the challenges facing the EU. The analysis shows that at the macro level Horizon 2020 was a response to the external and internal challenges facing the EU. Evaluations of the previous programmes, notably FP7, and the feedback from various stakeholders, also influenced the process. Horizon 2020 signals a shift in the institutional logic of EU research funding, by moving from a scientific logic towards market logic. Earlier funding programmes focussed on development of scientific knowledge, Horizon 2020 emphasizes a focus on innovation and commercialization of scientific knowledge. To be able to achieve this, Horizon 2020 compels a more significant role for industry, emphasizing better and earlier integration of industry in the research and innovation process.

As Horizon 2020 has a strong focus on enhancing the participation of industry in research and innovation, along with ensuring more collaboration between universities and industry, the next part of this paper will look into how FLSmidth handles innovation and their view of collaborations and accessing public funding.

7. Analysis – Micro level

In this section I will present and analyse my interview data, to find out how FLSmidth deals with innovation and collaboration with external partners. This section will be divided into four sub-sections covering the important issues discovered during the interviews that were identified as important in the understanding of the current research and innovation approach of FLSmidth. In the interviews, I first asked about FLS's innovation and collaboration strategies. Then about the role of public funding in collaborations, open innovation and network ties. In each sub-section the interview data is presented starting with the strategic level, and followed by the managerial and operational levels. After presenting the relevant interview data, the answers from all three levels are analysed and examined in the part-summaries, using the academic literature presented earlier in this paper.

7.1 Innovation and collaboration views

This section will provide an overview on how the participants view innovation and collaboration, and what is seen as important for successful innovation and collaboration with external partners.

7.1.1 Strategic level

At the strategic level in FLSmidth according to Kimmo Vesamäki, Senior Vice President, Group Research & Product Review, there are multiple factors viewed as key for successful innovation. One is **competence**, such as in skilful resources available as and when needed, and the ability to guide these competencies towards possible changes in research and development or in innovation efforts. As things can change due to prevailing circumstances, there have to be competent people in place to ensure change can happen when required. Having a **clear strategy** is highlighted as another important factor. This is not just related to the company strategy or business strategy, but how it links with the R&D and innovation strategy.

"*And we say that, basically where we are, in the industries we want to serve, we want to be number 1 or number 2. There is no room for number 3, 4 and 5." (*Kimmo Vesamäki)

At the strategic level besides competence and strategy, the third important factor is **seeking excellence** by focusing on R&D and innovation efforts in areas where FLSmidth is or can be number 1 or number 2 in the market. If that is not possible then it's not an area that FLSmidth to engage in. It's not necessary to be number 1 in technology if FLSmidth can use other factors to attain the position of number 1 or number 2 in the market. Besides the three mentioned factors at the strategic level, there is also importance given to **funding** as a key factor in achieving successful innovation. Among the resources needed for successful innovation, funding is viewed as key factor.

The **mentality** of the company is regarded as another important factor. It is viewed as important for the

company to be actively seeking to innovate, look for future solutions, etc. The mind-set has to open for that, if not then the company will be outperformed by others.

Having a strong technology base is regarded as important to be number one in the industry. The subsequent mentioning that technology is not the only area which can make FLSmidth number one reduces the importance of technological leadership as a whole in the overall strategy. But factors such as mentality and mind-set in company, seeking innovation and new solutions are important to be able to achieve successful innovation and collaboration, along with technological leadership.

7.1.2 Managerial level

At the managerial level **funding** and **commitment from the top management** are seen as key factors for successful innovation according to Hannibal Nielsen, Department Manager, Research, Valby. To be able to succeed there has to be a long term commitment from the top management to invest in research and innovation without expecting a product as a direct result from the efforts. It has to be seen as a long term investment. Without that type of commitment backed by adequate funds, it is difficult to achieve the desired results. Funds have to be made available to ensure that aims can be met, and the necessary research conducted. Intentions alone cannot solve the issues. **Competent** people are also a necessary factor to ensure that the results can be achieved. There is also a need to involve internal and external **stakeholders** into the process. Input from external stakeholders outside of the industry can be a valuable source for gaining a successful output from the process. By involving customers and clients FLSmidth is able to gain useful market data, and also inspiration on how different problems can be tackled, and a clearer picture of what the actual problems are.

*"…we have some customers and clients that we are in close cooperation with because then we get very close market input, and we get some inspiration of how we could solve different issues and we get a very clear picture, what are the problems and what is it that we have to solve and what are the perspectives in what we are doing." (*Hannibal Nielsen)

The involvement of clients, customers or other external partners has also other benefits. FLSmidth employees working on various research projects, can by engaging these different actors, see the practical application of their research, which can be a motivating factor. Once the problem becomes clearer or the client's needs properly understood, it gives the researchers more motivation and a sense of direction in their research, which could otherwise not have been achieved by working in a closed environment.

According to Ole Mogensen, General Manager, Research Centre Dania, collaboration with others for successful innovation requires that FLSmidth is able to gain some competencies or specialist knowledge

which otherwise would not have been available. It can be beneficial if FLSmidth is able to access that knowledge, and make use of it in its business areas.

On the issue of innovation, Ole Mogensen doesn't think FLSmidth is innovative enough. There is a clear need for having a sustained effort for radical innovations, so that a certain amount of **risk** is accepted to ensure that proposals which seem risky are not overlooked at first but given consideration and time to be fully understood. Accepting a high amount of risk on some projects, and then after failure to reach targets, shutting completely for any risky proposal is not a beneficial approach towards innovation. FLSmidth has in the past had a tendency to take bold steps on some project, where a lot of funds were provided, but after failure to that project, the willingness to take risks diminishes, which hurts the overall innovation.

*There is a tendency that in FLSmidth, sometimes you take very bold steps were you spend a lot of money on one idea that for some reason gets a lot of support, at least initially and therefore all the pocket books open and are willing to spend money on that idea, and then later on when that idea, that initially seemed so attractive proves to be a failure, then you retract and you become overly conservative for a number of years after that experience. Whereas what you should have done is that you should have invested a reasonable amount of money in examining that idea or that concept more closely but you should not go all the way to industrial scale at a premature time. And that one hand is driven by a pressure to shorten time to market, there's big top-down pressure to shorten time from idea to market, and that kind of pressure can lead to these kinds of disastrous mistakes that are extremely expensive. (*Ole Mogensen)

To avoid this, Mogensen suggests implementation of a formalized approach to radical innovation, where a certain share of the R&D budget is allocated for high risk radical ventures, making it possible to pursue ideas within some budgetary limits. The remainder of the R&D budget can be used for other low risk ideas with higher probability of success. Suggesting some form of balance between the different ideas, as low risk equals low gains and high risk equals high gains. The balance in the budgetary allocations will ensure that expensive mistakes are not made and that potentially lucrative projects are not put off due to failure somewhere else.

7.1.3 Operational level

According to Klaus Hjuler, Research and Development Engineer, it is important to have **clarity** on what FLSmidth aims to achieve from a project and how that project fits in to the overall process. If the project description is not detailed enough, it is hard to figure out what the purpose and aim of the project is and how to achieve it.

I think one way is to prepare the projects, to think about carefully what we FLSmidth want to achieve from this project and to formulate a project description of the scope of the project very carefully and prepare it. (Klaus Hjuler)

If there is not a clear objective FLSmidth runs the risk of engaging in projects with external partners, where the aim initially thought of, would not be the driving force throughout the project, leaving FLSmidth with a result that does not tackle the initial challenge. PhD students and other researchers involved could find themselves working on projects that do not bring value to the company, and not directly linked to the company's strategy or business operations. When engaging external partners and hiring PhD students, it is important to have a clear description of what the company wants to achieve and this should be supplemented with adequate **funding**, to ensure that the projects are able to achieve their aim with lacking resources.

Innovation facilitator Thomas Hørup believes that successful innovation is about creating value for the customer. To be an innovation it has to be adding value to FLSmidth or the customers. According to him it's dangerous to put too much value on what types of innovation, such as incremental innovation, evolutionary innovation or breakthrough innovation, is better or worse. The focus should be on what is important for the company right now. Therefore it is important to define the types of innovation and then pursue the innovation that provides the best fit, but it is necessary to have some work on breakthrough innovations going on acceptance of the risks attached.

According to Thomas Hørup, it is important for the innovation process that you have a clear idea of what need you are trying to address, the challenges in the industry and what it can solve for the customer. Asking the right question is fundamental for innovation, as that is the key starting point of any innovation process. He also emphasises the need for competent people at the right stages in the process with the right attitude.

I think from an innovation point of view, the right attitude and skill set from the management is important, that there is an acceptance of the risk of failure, and also to be very mindful of how success is measured. (Thomas Hørup)

He also emphasizes that there is an acceptance of the risk of failure. If the innovation process is solely measured on the basis of products that come out of it, then FLSmidth risks creating behaviour that is not ideal for innovation. The management has to be able to acknowledge the risks associated with innovation and recognize innovators for their efforts, as taking risk is crucial for innovation.

7.1.4 Part Summary

At all three levels funding, strategy and competence are regarded as key factors for achieving successful innovation. The allocation of financial resources for innovation was seen as key by Schumpeter, who acknowledged that significant resources needed to be allocated for it (O'Sullivan, 2006). The innovative process requires strategy, funding and competence building by learning how to transform technologies and access new markets (Lazonick, 2006). The absorptive capacity is acknowledged as being important. These factors are all important, and must be handled accordingly in the innovation process. As the interviews show there is agreement on the importance of these factors at all levels in FLS.

Mentality of the company is regarded as important at the strategic level and operational level. For a company that has traditionally used closed innovation, it is a difficult challenge to change mentality and culture towards more openness (Nakagaki, Aber, & Fetterhoff, 2012). FLSmidth relies on closed innovation, so for FLSmidth to embrace collaboration and open innovation, a mentality change will be important.

Strategic level:	**Managerial level:**	**Operational level:**
Funding	Funding	Funding
Strategy	Strategy	Strategy
Competence	Competence	Competence
Mentality of the company		Mentality of the company
	Willingness to take risk	Willingness to take risk
Seeking Excellence		
	Involving Stakeholders	

Summary of the interview data. (Table 3)

Besides the similarities, there are also areas where there are different views. At the strategic level, it is stressed that FLSmidth should only engage in areas where FLSmidth can achieve a leadership position. It is interesting to note that the willingness to take risk is not seen as an important factor at the strategic level. For innovative firms path-dependency can be a problem. Therefore firms need to have flexibility to pursue a better path when available. The more risk willingness the firms strategy is, the more likely the firm is to form alliances (Grodal, 2005). FLSmidth at the strategic level is somewhat risk averse. By looking at the collaboration aspect of innovation, it's also interesting to note that the involvement of stakeholders to the innovation process is only seen as important at the managerial level and not at the other levels.

7.2 Public Funding and Collaborations

This section looks at the participant's views on the role of public funding in research and innovation. They were asked about their views on FLSmidth applying for public funds and the collaboration process with external partners. The administrative challenges associated with the process where also discussed, and all participants were asked if public funding could be a future option for FLSmidth.

7.2.1 Strategic Level

Kimmo Vesamäki, Senior Vice-president sees public funding as important enabler of R&D collaborations. The NCPT platform with DTU is an example of how public funding has enabled FLS to collaborate with an external partner. Public funding plays an important part in collaborations and creates opportunities for working with different partners. Without public funding some of the research in the platform might not have happened. The main challenges for FLSmidth in using public funding for research and innovation, is the uncertainty of the application process. The amount of resources needed to find suitable partners that fit the framework of the funding requirements is another challenge. Initiating the application process, requires many resources, and therefore requires some certainty that the application will be successful.

*So that's kind of a starting point is that you need to have the right approach, right project, right players, right targets, and then is that going to match the potential funding. Then you calculate that, if I put so and so much hours to make this application, you need to have some type of a gut feeling on your own side that, is it even feasible. (*Kimmo Vesamäki)

7.2.2 Managerial Level

At the managerial level public funding is seen as important for research and innovation, but for FLS to be able to adequately take advantage from public funding would require strengthening of the research department by adding more resources and manpower. When the funding is approved it gives FLS access to external resources that are highly beneficial. The main challenge is that to access public funding, you need to spend a lot of resources on the application process. These resources might be available.

Off course if you have this platform project, we increase our internal resources with the students coming in from the outside. (Hannibal Nielsen)

The application process is seen as cumbersome, requiring a lot of effort initially to get the funds. When it's approved and the funds are released, another resource constraining issue emerges, the documentation and reporting that is required. This again requires sources to get done.

I think it's important if you decide to start some more intensive work as a company on finding funding that you should also have the people also, and be aware that it requires a lot of resources to get the funding. (Hannibal Nielsen)

Hannibal Nielsen, Research manager, believes that the NCPT platform would not have taken place without public funding. Due to the resources needed for a collaboration process to begin and to move, without public funding it would have been difficult for FLS to take part in such collaboration. Resource constraint would have forced FLSmidth to give it lower priority until resources were available.

Ole Mogensen has similar views on the role of public funding for research. He believes that without public funding the NCPT platform would have been much smaller in size and with a much narrow scope. Having access to public funding, has enabled FLS to engage external partners and undertake research that otherwise might not have been done.

Lars Skaarup Jensen believes that public funding is a difficult process that requires a lot of effort without any assured return. To be able to get access to the public funding, required being part of a network. That will give access to knowledge on what is seen as fundable project, along with assessing the mood in the network regarding a research projects. But the difficulty of the process makes it a less attractive endeavour.

*One of the things which would hold back applications is that they spend a lot of resources and have a lot of waiting time without really knowing what's going to come out of it, whether it's worth the effort. And I think that is also easier if you have a strong network. Because then you have better feel of whether it's worth the effort or not. (*Lars Skaarup Jensen)

One key area where public funds can be crucial is when testing new prototypes. Lars Skaarup Jensen was part of a collaboration 10-15 years ago with multiple partners, which was able to get EU funds to setup a prototype for a HOTDISC[2], a device which enables the use of coarse alternative fuels like waste, without needing fine shredding of the materials. The funding from the EU was very important for the project as it enabled the prototype, and today the HOTDISC is a part of FLSmidth's product portfolio. Another part of the same research project, a new kiln concept had to be abandoned because funding wasn't available for a prototype.

The negative aspects of that collaboration project were the formal and reporting requirements, which started discussions about whether the funding was worth the effort or not. If there are other partners involved, a lot of time and energy is spent on maintaining formal requirements, reporting, meetings, etc. which can have a tendency to take away the focus from the project .

7.2.3 Operational Level

According to Klaus Hjuler, Research Engineer, public funding can play an important part as a driver for research. Public funding provides opportunities for research that otherwise might not have been initiated, and boost to other research projects. He expresses that there is a difference of opinion in FLSmidth, where some senior employees believe that FLSmidth should concentrate on internal research, but there is

[2] HOTDISC: http://www.flsmidth.com/~/media/Brochures/Brochures%20for%20kilns%20and%20firing/Hotdisc_Combustion_Device.ashx

gradually more acceptance of the idea that publically funded collaborations should be considered.

I think nowadays we are more modern and we would like to have this external collaboration, and in that case external funding is important. (Klaus Hjuler)

In cases where the initial research has been conducted and delivered positive results, and there is a need to test it in a larger scale before it's ready for market entry, it can be difficult for firms to absorb the entire cost of such large scale testing. A costumer might not be ready to pay for a technology that has not been tested outside a laboratory. For a research department, testing in a large scale could entail that entire year's budget is directed towards that one initiative. In such circumstances it becomes necessary to get public funding to ensure that emerging technologies are not discarded due to lack of funds for testing.

7.2.4 Part Summary

There is an understanding at all three levels of FLSmidth that public funding can play an important role in research and innovation collaboration. More possibilities can open up, and things that were not possible otherwise can become possible. There is also the added factor that collaboration can encourage firms to seek new and different partners, that otherwise would not have been engaged in a similar manner. External partners can provide access to new knowledge and more resources.

Engaging external partners outside of a publically funded collaboration can have high transaction costs. The interviews have shown that lengthy contract negotiations on goals and aims of the collaboration, who gets IP rights, financing, etc. are issues that are seen as barriers for collaboration. There have been examples in FLSmidth where even after lengthy contracts the collaboration did not materialise due to lack of understanding between the parties. The NCTP collaboration on the other hand is being conducted with public funding and under the umbrella of the Advanced Technology Foundation, which provides an institutional framework making it easier and less costly to engage external partners and reducing risks.

There is an understanding at the three levels in FLSmidth that although public funding has its benefits, the application process and the need to spend considerable amount of internal resources on the application process without any assurance of success, makes it less appealing, particularly if a research department is already low on personnel. It presents a dilemma for managers, because on one hand it can provide extra resources for research departments facing resource constraints, but to get access to the funding and more resources, they are required to spend their already limited resources to access it without any assurance of getting it. Firms that have resources available will be better placed in accessing those funds and compared to firms facing resource constraints.

From a managerial perspective, the long term nature of such collaborations and the aspect that the research might not be directly marketable as a product for costumers, could make managers prioritize against such collaborations and focus their resources on internal projects that are directed towards commercial exploitation in the short- or mid-term. On the other hand, the lack of internal resources could serve as a motivator for seeking external collaborations. There might be projects that cannot be taken up internally due to lack of available manpower or competence which would require access to external researchers, PhD students, etc. who could come in and provide extra brain capacity.

The biggest impact for public funding as the interviews have shown is in prototype development. As the HOTDISC example shows, public funding for such projects can be crucial and can help firms enhance their research capacity. The uncertainty attached to research results and their commercial application, can make it difficult for firms to invest the necessary funds, making it crucial for successful research activities to have access to public funding. Otherwise ideas like the HOTDISC could have faced the same fate as the new kiln concept, which could not be taken to prototype phase due to lack of funding.

7.3 Open Innovation

This section looks at how open innovation is viewed by FLSmidth. During the interviews the participant's at all three levels were asked question regarding open innovation approach, its key challenges, and how it can be used by FLSmidth.

7.3.1 Strategic level

In research and innovation collaborations, FLSmidth considers the protection of IPR as the most important issue. Any consideration of openness in the innovation process depends a lot on what sort of protection FLSmidth can secure.

With regards to EU funding for research, the IPR issue is the most crucial element for FLSmidth. In the NCTP collaboration, the Advanced Technology Fund had certain legal requirements which were interpreted in a manner which ensured adequate protection of IP. FLSmidth was given the right of first refusal. If FLSmidth considered the IP to be relevant for its business it could purchase under previously agreed terms. If FLSmidth was not interested in it, DTU was able to use it as they deemed fit. For EU funding to have any appeal, similar form of IP protection is necessary. As FLSmidth is required to put some of its own resources in the collaboration, financial or otherwise, there is an expectation that there should be some IP related benefits for the industrial partner. How the rules on IPR are formed will be a critical aspect for FLSmidth when considering EU funding for research and innovation collaborations and engaging in open innovation.

Kimmo Vesamäki, Senior Vice President believes that when it is possible to have openness in collaborations

then it is a benefit. But the openness has to be limited to a manageable group where the members of that group can openly share knowledge, within a mutually agreed framework. There is an acknowledgement that openness can support the innovation process, by giving FLSmidth access to external ideas, and using external knowledge to improve internal solutions, but complete openness is seen as a less likely proposition due to many restricting factors, mainly due to risks to IPR.

So I would say that openness is great, and supporting the innovation always when you are able to use it. But there are many limiting factors which say that you can't do it open for all. But off course open for the partners in specific issues. (Kimmo Vesamäki)

At the current level the openness related efforts are directed at ensuring that when participating in research projects with partners that are not competitors in the market, they can share knowledge and ideas openly. The mind-set of those involved should be geared towards openly sharing. If the open mind-set is created, then it allows you to move faster and be more efficient.

And then off course I mean, it's clear without saying, that we discussed earlier, this competence that really has to be at the level we seek, it has to be something or somebody who is able to complement and increase our competence level some way or another. (Kimmo Vesamäki)

In current collaborations there is focus on getting access to external competencies that can complement or enhance the R&D level. Developing long term relationships with universities and firms that can become stronger over time is also important, and thus making it easier to have a more open process between the parties involved based on trust. Beyond that adopting the open innovation approach is not possible.

7.3.2 Managerial Level

Hannibal Nielsen, Research Manager also believes that IPR is an important issue. The collaboration agreement must address IPR concerns, and provide a clear method of settling IPR ownership issues. IPR is the biggest concern for FLSmidth, because when engaging with external partners, there is always a risk of not being able to fully control the IP that you share with your partners. In a collaboration the key question is how open should you be without risking too much. To ensure adequate IPR protection, the IPR department helps the managers by proactively dealing with IPR in any new project to avoid risk.

One of the most important things is the IPR. Who owns the rights and how do we split, if we get an idea in a platform like this, who has the right to do this idea, and how should we move this idea around, and who has the first priority to buy the idea or to utilize the idea. (Hannibal Nielsen)

The importance of IPR protection is seen in the context that in a challenging market where competing on

price can be difficult, technology is an area where FLSmidth could differentiate from its competitors. Technology and new ideas can provide a competitive advantage. This makes the protection of IPR very crucial for FLSmidth.

When entering into collaborations with external partners, IPR protection and agreement on who owns what has top priority. FLSmidth's past experiences have shown that having good initial agreement, can to a large extent help defuse potential problems that do emerge regarding the ownership of IPR. In one instance, where FLSmidth was collaborating with two other firms, one of the partners handed in a patent application based on the ideas discussed in the collaboration. Due to well-defined agreements, the issue was solved and the patent application was retracted. Past experiences mean that FLSmidth has dealt with IPR issues in the past, and has knowledge and practical experience of how to deal with them in the future.

Not having well defined agreements runs the risk of creating unnecessary confusion and ownership issues over IPR. The time used on sorting out IPR disputes, hampers the overall focus of the collaboration, and lack of trusts increases the application of dispute settling mechanisms, reducing the amount of time spent on research. The success of collaborations depends a lot on having well defined IPR agreements in the beginning of the collaboration process.

Hannibal Nielsen believes that use of open innovation should be based on a pro and con accounting, by analysing the benefits of open innovation versus the risks related to open innovation. He mentions that open innovation is good for getting new inputs and fresh eyes on things, as compared to a closed group where there limited risks to IP, but the process will get limited inputs and get stuck some with conservative ideas. On the prospect of open innovation being used by FLSmidth in the research and innovation process, he believes there are some mostly older employees who are not comfortable with that approach. It will therefore in the near term be difficult to engage in open innovation. For the future he sees open innovation as a tool to move away from a conservative mind-set and open up to new inputs and fresh ideas. Regarding patents, he sees them as important tools to safeguard the knowledge and ideas that have emerged with the involvement of FLS.

Handling patents is a complicated matter as obtaining a patent can cost a million DKR. So there has to be a commercial value attached to the knowledge before going in for a patent. FLSmidth carefully examines all patents, to see if they have or will have any commercial value, if not then they are published.

Quite often we have some rounds where we go through some of the patents where we can see after 5 years we have obtained the patent, but we can see that we are not using not utilizing the patent. And try to evaluate, is it anything, do we expect that we before it's running out, we will utilize it. If we consider not,

then we publish the patent and make it available to everybody. (Hannibal Nielsen)

According to Ole Mogensen, Research Manager FLS Dania, drafting an agreement on the ownership of IPR is the most difficult part of the collaboration, as everyone wishes to get the biggest part of cake. Ultimately some agreement has to be made, and that is difficult. Another difficult area is keeping the research to whatever extent possible open but within certain limits. Besides IPR ownership there are also concerns regarding what knowledge should be shared openly and what should be concealed. The NCPT collaboration with DTU was relatively simple as there were only two partners involved, and only one private company which had commercial interests. DTU was content with getting payment for ideas or inventions that FLSmidth wanted to commercialize. Had there been more commercial partners involved, it would have been more complicated.

Ole Mogensen believes that open innovation is already being practised by FLSmidth, but with some limitations. The current cooperation with universities and some customers is seen by Ole as open innovation within a contractual framework that sets some limits. He doesn't foresee a situation where FLSmidth would use full scale open innovation.

If you by open innovation you mean completely open innovation, where you conduct everything on public chat channels or something like that, I don't see us participating at that level of open innovation. Because we lose the possibility to protect what good ideas we might get. (Ole Mogensen)

In the future open innovation in its fuller form could be an option, if the knowledge is seen by FLSmidth as being sufficiently far from commercial exploitation. The knowledge has to be more of a basic or fundamental knowledge that improves the understanding of something, and not such that can be made into a commercial product, service or have any other commercial applications in the near term. As an example Ole Mogensen mentions FLSmidth's partnership with ECRA, the European Cement Research Academy, where research is carried out and results of that research made equally available to all members.

When asked if FLSmidth has used IP that wasn't a part of its business model to enter new markets or bring to market new products and solutions, Ole Mogensen mentioned that FLS Miljø, a part of the FLS Group, had in fact made some discoveries that led to new products. The "spill-over" technologies where sold in 2004/2005, and at the same time FLS Miljø was dismantled, as the FLS Group wanted to concentrate on its core business. Beyond this there were no other examples of FLS using spill-over knowledge from R&D and collaborations to enter new markets and using IP to create new business opportunities. The managerial level participants agreed on the effort to focus energies on the core business of the FLS Group.

Lars Skaarup Jensen, Department Manager Valby, believes that if the contract negotiations begin by discussing the IP rights, the process can be hampered by tactical considerations where all parties try to position themselves to achieve maximum benefits regarding ownership of IP. The difficulty of putting value on IP at an early stage also complicates matters. He seeks a new method of solving the IP issues.

"I would say that the best way for overall society perspective would be to make the agreements so that the company gets all of the IP rights and the university gets something else in the deal, so it's a trade, so you don't need to consider, the same if you get in the discussion that the university has got some, the agreed benefits, one type of benefits and the company has another type of benefits." (Lars Skaarup Jensen).

Trying to address IP concerns by strengthening the contract could result in the creation of unnecessary bureaucratic hurdles, increasing transaction costs and making collaboration difficult. It is important to have a contract to begin the initial engagement and create a framework for the collaboration and give structure to the process and some assurances on IP issues, also provide a clear division of responsibility. But it is also equally important to ensure that the contract requirements, bureaucracy and secrecy don't end up constraining the process.

"… One thing to be careful of is that it should not be a bureaucratic process and in innovation you need to ignite the passion and involvement across a team and I think that's the difficult part." (Lars Skaarup Jensen).

7.3.3 Operational Level

According to Klaus Hjuler, Research Engineer, it's important to get agreements on IP in the beginning of a collaboration to ensure that ideas generated by FLSmidth can be patented by FLSmidth. Otherwise there is a risk that ideas generated in the collaboration, are not made available for FLSmidth to commercialize. But even good paperwork on IP in the early stages, cannot solve all problems. Klaus Hjuler mentions an example where even after 2 years of paperwork there were disagreements on the IP.

I think that maybe it's not possible to protect, you cannot protect 100 % even if you make two years of paperwork with the lawyers, IPR contracts, and… I don't think you will have full protection anyway. (Klaus Hjuler)

Klaus Hjuler believes that openness can only be an option in research that has long term applicability and is not a threat to any current product or ongoing research on small modifications to existing products and solutions. For openness in research to be considered an option the intended area of research has to be according to his timeframe, approximately 10 to 15 years from market. FLSmidth considers many different technologies for long term research, and open research on those areas can be an option. As an example he

mentions an ongoing research partnership with DTU Risø, which is looking at how some type of membranes can be used to separate oxygen from air. FLSmidth is interested in knowing how those membranes could be used in cement production.

Our business right now is with existing equipment or maybe small modifications to existing equipment, but in the long term we look at quite other technologies that could replace perhaps the known equipment. (Klaus Hjuler)

Along similar lines, Thomas Hørup, Innovation Facilitator believes that trust is an important element in collaborations. If the collaboration is packed in tons of legal requirements, it will not create an environment conducive for cooperation. There will always be some legal foundation for the collaboration, but there is also an element of fundamental trust between the parties.

I think don't underestimate the human element of trust in this, because if you need to package your collaboration in layers and layers of legal documents, I think it's, that might impede the collaboration even though you have the best intentions. (Thomas Hørup)

For long term research Thomas Hørup believes that openness can be a source of inspiration. He believes that openness is positive for the research process because it challenges your way of doing things, prevents you from growing stale in your methods, and the fact that you are required to be alert of the challenges in the process, forces you to be more attentive to the process. That can lead to the adapting of a more flexible approach towards research and innovation that can ensure quicker decision making and execution.

I think openness is a big source of inspiration, because when you close yourself as a company you are only feeding from the usual sort of, it's hard to break out of the mould of what you are used to doing, and it's difficult to think outside where you currently are. There are a few unique individuals that can do it, but as a large group it's very difficult, and there the more you open the more you are going to get challenged in your assumptions and the more you are going to get different perspectives on things. That is uncomfortable of course, but it is also highly fruitful for innovation. (Thomas Hørup)

But he also acknowledges that although he is positive towards openness, there are still necessities that cannot be overlooked which can require having a closed process. In the future, funding constraints might require more open partnerships to reduce costs and be more efficient. According to Thomas Hørup, one option for the future could be using more collaborations and he believes that the company is moving and now the word open innovation can also be heard once in a while.

7.3.4 Part Summary

There is an understanding at all levels that open innovation is necessary for the future, and that increased openness in research and innovation can be beneficial. For FLSmidth to be able to fully engage in open collaborations there needs to certain safeguards in the process that protects IP and gives FLSmidth some control over the knowledge shared and created in the process. Both at the managerial level and operational level, there is awareness that while contractual safeguards are necessary in collaborations, these should not be so severe as to constrain the open sharing of ideas and knowledge. The biggest challenge for FLSmidth is to find the right balance between safety and openness.

As a large firm with a substantial R&D and knowledge based assets FLSmidth is attractive for potential collaboration partners as it offers many complementary assets and high level of synergies for the integration of external knowledge. Economies of scale and reduction of R&D expenditure, although not mentioned in any of the interviews, is a substantial reason for FLSmidth to engage in open innovation and build on the current use of collaborations with external partners. According to Torkkeli et al. (2009) firms with a high level of absorptive capacity and access to external networks and highly skilled staff, lean towards open innovation, yet in the case of FLSmidth, having a high level of absorptive capacity, access to external networks, skilled people, etc. and yet the culture within the firm is not conducive towards open innovation.

IPR is the key issue for FLSmidth when considering open innovation. All participants agreed that without substantial IP protection engaging in any kind of collaboration with an external party would not be possible. In cases where IP protection is available, the trust factor comes into play and past history of the partner can be influential when commencing a collaboration. Partners like DTU, with whom FLSmidth has a long history, will be preferred over partners that do not have a similar relationship with FLSmidth. Such an approach decreases the risk associated with engaging external partners in R&D collaboration. Having a history of cooperation also reduces IP related contractual stumbling blocks that could prevent meaningful knowledge sharing. Many FLSmidth employees are graduates from DTU, and the inter-personal connections also play a significant role in collaborations as mentioned by some participants. When working with new untested partners, contractual matters regarding IPR were time consuming, and even after the contracts being signed, meaningful knowledge sharing was not possible. Working with the same trusted partners, makes it easier to openly share ideas among those involved because of high level of trust. On the negative side, people who have been collaborating in the past, and from a similar background, will have a similar approach and ideas.

Among the challenges for FLSmidth in using an exploratory strategy is the need to access new ideas and new knowledge, which entails shifting from the comfort zone of engaging mostly trusted partners. By

moving beyond the trusted partners, and using new and un-tested partners, according to Chesbrough (2006) Torkkeli et.al. (2009) the exploratory strategy will enhance access to new ideas and knowledge. This strategy will also require FLSmidth to continue engaging relevant networks, while leaving redundant networks. Kimmo Vesamäki mentioned that this is happening.

To be able to fully utilize the knowledge gained from external partners, the absorptive capacity must also be enhanced, otherwise according Faberberg (2005), valuable external knowledge could be wasted due to "not-invented-here" syndrome. He also mentions that being efficient at handling internal processes using cumulative and embedded knowledge can be a hindrance when seeking to utilize external knowledge that challenges the methods used to handle those internal processes. To handle these challenges awareness is required at the strategic level regarding the absorptive capacity of the firm.

The FLSmidth approach of engaging primarily trusted partners like DTU for collaborations can also be problematic. According to Faberberg (2005) firms that only engage trusted partners in close-knit innovation networks risk taking the problems faced internally to the group level, where the firms develop a common view on the challenges they are facing, leading to a "group-think". Therefore to fully be able to take advantage from an exploratory open innovation strategy, it is important for FLS to seek new partners and not only engage with trusted partners.

On the utilization of patents in new business models, Ole Mogensen mentioned a project of FLS Miljø which produced technology spill-overs that were turned into new products. Knowledge produced in collaborations that is not of use in the current business model, gets stored in a knowledge bank where it can be used to help improve the firms overall level of knowledge. There are currently no processes active where other avenues beyond the current business model, are pursued for commercialization of such knowledge. Viewing this from an open innovation perspective, the current business model is preventing a more open approach towards commercialization of spill-over knowledge beyond the current business model. To unlock the full opportunities of an open innovation approach there is a need to better utilize the patents portfolio of the company and view spill-over knowledge from collaborations as a new opportunity.

According to Chesbrough (2006) internal and external ideas should be treated equally. This is also something that does not seem to be the case in FLSmidth currently. The main focus of the R&D department is on internally generated research and ideas. External knowledge is used in an exploratory way. Silo mentality and the "not-invented-here-syndrome", mentioned by Torkkeli et al. (2009) could be reasons for why external knowledge does not feature more prominently in the R&D process.

The current interest in open innovation in FLSmidth is limited to the idea generating phase. From the

strategic perspective the engagement in collaborations and networks is primarily at the exploratory level. The strength of the exploratory approach is in gaining access to new sources of knowledge by collaborating with new partners. In the NCPT platform, a new industrial partner has entered the collaboration. Similarly by entering ECRA, FLSmidth has opened up to new potential partners. To gain full benefits from open innovation, external ideas and knowledge would have to play a bigger part in the R&D process beyond the initial idea generation phase. For the exploratory approach to open innovation to succeed in accessing new ideas and knowledge, new external partners should be engaged beyond those already linked to FLSmidth.

7.4 Network ties and knowledge sharing

This section shows how FLSmidth engages partners for collaboration, participates in inter-organisational networks, and handles knowledge sharing and what factors impact decision making. To get a perspective on knowledge sharing with external parties, some questions were also asked on how internal knowledge sharing is done to get a picture of how the transfer of knowledge is handled within FLSmidth, to see what aspects of the internal challenges were similar to external challenges. A reason for using this approach was to enhance the data pool. The NCTP platform was used as a starting point to understand if it was a unique case or something which FLS felt comfortable with, and could serve as model for future collaborations.

7.4.1 Strategic level

When choosing academic partners the focus of FLSmidth has been on choosing top universities according to Kimmo Vesamäki, Senior Vice President. As the headquarters are located in Denmark and for historical linkages, a lot of the cooperation with universities has been with Danish universities. The mineral division of FLSmidth in the US also seeks collaboration with universities from regions with a mining. Universities from countries where external funding is available as in Denmark are given a higher priority.

The European Cement Research Academy (ECRA) is also an important partner. Other associations of similar nature could be potential partners, and in the minerals division of FLS there is also scope for partnering with similar associations. On a smaller scale, there are possibilities for limited level cooperation with other firms. All options are open, and the best match based on the need at hand will be chosen. Collaboration will be established with partners where there is some commonality that can form the basis of cooperation.

FLSmidth has been involved with different types of entities for research collaboration in different shapes. The initial learning curve has been done already according to Kimmo Vesamäki, Senior Vice-President, and there is awareness of what can be possible and what the challenges there are. The aim is to be always working with the most relevant players available. For the collaboration to be successful there is a need for both parties to get some benefits from the collaboration. Besides being relevant for the research, trust is important. Although contracts can be made, there still has to be some level of trust between the partners

to ensure that the contract will be respected. Besides trust long term commitment is also important.

So that's one thing trust, but also in addition we typically want to see some type of a longer term commitment, longer term value sharing or value adding. It's much better to deal with less partners in longer term perspective, fully knowing that some issues are short term or very unique or specialized things, which are a different discussion but, if you think about universities work and institutes, they are typically ones which are there for longer period of time. Then it's, to build up this common platform together is much more valuable and stronger, then just trying to seek something quickly from some place and then disconnect them and try something else. (Kimmo Vesamäki)

Once the partner has been chosen and ties established, Kimmo Vesamäki believes that knowledge sharing is very important for collaborations, but it's also very important within the company. It's important to ensure that knowledge possessed by senior employees is not lost when they retire. There is a need for that knowledge to passed on to others or stored electronically.

So you do lots of work, collect knowledge and then gain knowledge, and if you are not able to document in such a way that it is sustainably available, you will actually need to do it again. (Kimmo Vesamäki)

There is focus on getting the tacit knowledge codified so it can be shared easily. This is a difficult task, and Kimmo Vesamäki has experience with it from his previous jobs. He sees it as an industry wide challenge, and perhaps also across industries. One of the challenges is to first establish which parts of the tacit knowledge are in fact true. Over time as knowledge is shared between people, there is a tendency for a "war stories" type of effect, where the knowledge that is shared isn't necessarily related to the actual facts. There is therefore a need to establish the facts and then ensure the facts can be turned into knowledge which can be codified and then shared. For example if an experiment that has been conducted some time ago, the people involved might have based it on some form of tacit knowledge, but it's important to have the exact knowledge documented so that a similar experiment can be re-created in the future. While there is focus on improving knowledge sharing within the company, there is not a similar effort regarding sharing knowledge with external partners. But the internal learning experience is important for FLSmidth.

7.4.2 Managerial Level

Trust in networks, is also seen as very important at the managerial level. According to both Hannibal Nielsen and Ole Mogensen, FLSmidth has come a long way in terms of working with universities like DTU to supplement their own knowledge. In the past the thinking was that such collaborations should be avoided altogether. But now there is an understanding that engaging external partners is necessary. Trust is a key challenge in collaborations. A contract can give you some safety, but working in a collaboration with a

partner where the trust is limited, will quickly turn into a struggle about imposing restrictions whereas with a trusted partner, if need arises and the parties agree, the contract can be interpreted more openly and less restrictive, which can be beneficial for the overall research efforts knowledge sharing.

As choice of partner universities like DTU, Aarhus University and more recently Aalborg University are highlighted as valuable partners along with ECRA. There is a belief that a DTU type partnership could be applied to others but with some modifications as the NCTP platform agreement which initiated the collaboration with DTU was formed on the basis of existing trust and the previous history between the DTU and FLS.

Hannibal Nielsen, Research Manager Valby, believes that having clear goals and high level of commonality is very important for knowledge sharing in collaborations. If the goals of the projects are not clear then it will be a frustrating experience for all involved. This is something he feels has been a problem in the past for FLS. There is also a need for involving internal stakeholders in the project who can ensure that the projects are producing knowledge that is relevant, and ensure that the knowledge reaches those who can benefit from it.

To create awareness in the organisation of what is happening inside the R&D department, a "story of the month" initiative was launched by Hannibal Nielsen's department. The aim was to explain the challenges and share knowledge in a manner so people in all parts of FLSmidth, including those without engineering degrees, could also benefit from it. This way a large pool of employees could learn about the research being done in FLS and the challenges facing the company, as opposed to the knowledge just being shared in R&D department.

Nearly two months after my interview with Hannibal Nielsen, I interviewed Ole Mogensen, and asked him about the "story of the month" initiative. He also believed that it could have been a way of sharing knowledge internally among different parts of the company.

We published case stories from research; "what do we do in research", to allow other people in the remaining organization to see examples, read about examples of what we do in research. Partly to let them know that now we have some new results, but also to know the people involved in research. (Ole Mogensen)

Following the publication of the second story of the month, complaints came regarding the use of classified knowledge in the articles. This hampered the process and the initiative was put on hold. This highlights the challenge FLSmidth is facing in finding the right balance on how to share knowledge and maintain

confidentiality. Ole Mogensen believes that knowledge sharing should be restricted to the research department, and not the organization at large, as such sharing will increase risk of knowledge being known by competitors.

The research department does not share its ideas and knowledge in the global FLSmidth idea portal, which is managed by Thomas Hørup, the Innovation Facilitator. It manages its knowledge and ideas in an internal portal, where research staff can share knowledge between themselves, without risking any confidential knowledge.

In the NCPT platform with DTU, Ole Mogensen views knowledge sharing as an important part of the project. He highlights that whereas in the initial phases there is a lot of knowledge going from FLSmidth to DTU, where the PhD students are given insight into cement production technologies, and in the latter part of the collaboration this changes as the PhD students create new knowledge which is then shared with FLSmidth.

To ensure efficiency, each PhD students gets a university supervisor and a company supervisor, who is an engineer associated with the research department at FLS, who initiates the first level of knowledge transfer. Initially the engineer helps the PhD student establish a relationship with FLS and understand cement production and research conducted at FLS, and with time as the PhD students creates new knowledge, the aim is for the company supervisor to get knowledge from the PhD student and share it inside the company. Besides this approach to knowledge sharing, there are also status meetings, review meetings, etc. where students present their research to a wider group of stakeholders.

Internally this method of knowledge sharing is also used. Realising the importance of knowledge sharing, FLSmidth has adopted a structuralized approach to sharing knowledge internally. The knowledge sharing part is now incorporated as a part of a research project, so that in the final phase of the project researchers are required to disseminate the results of the project to the stakeholders and others interested in the research, by organizing knowledge sharing seminars, events, training, articles and reports. Besides the person to person sharing of tacit knowledge, there is also electronic sharing of codified knowledge. This way a selected group of people can gain access to the knowledge created in the research project, or other data or documents related to the project.

Although electronic tools are used to share knowledge, when asked if there was a system where an employee in one part of the organization needing access or information on a certain research area could find and contact another employee who would perhaps have such knowledge, then the answer was no. Currently the system is still to a large extent based on personal relations guiding one to the right person.

You would have to rely on either your own experience or network of contacts or you have to know somebody who can guide you directly to the right place and the right person. That's a big problem actually and it has become even bigger in recent years with the rapid growth rate of FLSmidth. There have been new companies acquired, and there has been very little effort, to make it known to the original part of the organization what competencies, are had by this recent acquisition that suddenly has become part of the company. (Ole Mogensen)

But there are certain departments which are able to communicate internally and are able to share knowledge across regions. Ole Mogensen gives the example of the process engineering departments, which are located in Valby (Denmark), Bethlehem (USA) and Chennai (India). When new research or knowledge is shared with one process engineering department, they ensure that it is also shared with the other process engineering departments. If deemed necessary, then employees from other parts of the company and from other regions can be invited to attend the seminars and other knowledge sharing events. Similarly in other departments, there is a dissemination obligation on the researchers, to ensure that the research reaches those who can benefit from it.

So we will have to rely on somebody else in the organization who did attend that workshop or seminar to pass on that message to his organization in a wider context. Then it would spread in ever larger circles that way. But how well that works, I can't really know, because it is out of our sight and out of our control. (Ole Mogensen)

Having a dissemination obligation is one thing but ensuring its implementation and that knowledge sharing is actually taking place is another issue. Firm culture plays an important part in this. When asked about this aspect, Ole Mogensen agreed that firm culture does play a big part in this, and he mentioned that in some parts of the organization, there is a tendency to withhold knowledge, to strengthen one's position over those who do not have the knowledge. That is detrimental to knowledge sharing. He hopes that it is not so common, but there are examples of it taking place.

Since FLS is a global company with operations in different parts of the world, the employees are also divided in different divisions and departments. In such scenarios it can be a challenge to prevent silo thinking. The current structure at FLS based on divisions, does not provide any clear incentives for cross-division knowledge sharing. Being focussed on what happens in one's own division, makes it difficult for people to think about what way their knowledge could benefit those in other divisions. As Ole Mogensen engages stakeholders in the cement division, he says it is difficult to get them to spend resources on research that could have benefit for other divisions, as their focus and responsibility is with the cement division and its

research priorities.

As a solution to this challenge, he suggests that the Group Function under Kimmo Vesamäki, which handles Group Research and Product Review and has by definition the responsibility for cross-division thinking, takes care of this challenge and encourages the divisions to look beyond the interests of the individual divisions. Beyond the Group Function, Ole Mogensen suggests that there is also a need for the division heads to be aware of the responsibility to go beyond the divisions they work in and allow thinking that goes outside their silo. He considers this to be an area where FLS is facing challenges. When asked if there is any possibility of cross divisional knowledge sharing between the cement division located in Denmark and the minerals division located in the US, Ole Mogensen said no, he believes there are too many factors that prevent it from happening:

And it's again this silo thinking that's… there are no real incentives for doing that plus it's extremely expensive, because we are located on opposite sides of the world. Also our geographical structure is really against that, and you cannot hope to have too cross divisional collaboration between people who have never met. Who have never had a chance to understand what the other colleagues are working with, having had a chance to see it first-hand. (Ole Mogensen)

Another issue which prevents a higher level of knowledge sharing is the patent bonus system. In its current shape, it awards the individual who describes the idea that may become a patent. If the idea is shared with others who have taken part in formulating the final proposal, the bonus will be shared by all those involved. This hinders knowledge sharing, as people are less inclined to share knowledge with others, as that will mean risking a portion of the bonus. Ole Mogensen believes that this perhaps creates an incentive for not sharing. He suggests that a way out of this hindrance in knowledge sharing could be to provide an incentive or bonus for sharing knowledge.

On the issue of knowledge sharing with external partners, Lars Skaarup Jensen, Department Manager Process Technology, believes that IP related issues are the biggest challenge. Due to IPR issues, free knowledge sharing is not possible. There are often situations in collaborations, where the partners do not present the data of their activities due to IPR concerns. This creates a lot of frustration. He has faced similar situations with universities, where knowledge sharing was restricted due to IPR concerns. These challenges need to be addressed to ensure knowledge sharing can take place.

7.4.3 Operational Level

Klaus Hjuler, research and development engineer, views trust as being important when choosing partners for collaborations. He also believes that the relationship FLS has with DTU is special, and he has not

experienced any problems when sharing knowledge with a trusted external partner like DTU. The reasons for that are the close relationship both organizations enjoy and the fact that Klaus Hjuler, like many other FLSmidth employees are former DTU students. Having similar background helps in terms of establishing trust between the partners and developing interpersonal ties. This also felicitates knowledge sharing. According to Klaus, when other partners are involved, it's difficult even after years of paperwork to ensure 100 % protection and similar trust.

During the NCTP collaboration, knowledge sharing took place by having meetings between DTU researchers, PhD students and FLSmidth staff, who could ask the PhD students questions about their on-going research and get insight into the results. For the PhD students this offered an opportunity to get feedback on their research and the possibility to engage and interact with people who's challenges they are trying to address. One major hindrance in these knowledge sharing sessions was the IP issue. If a PhD student had handed in a patent application, then that knowledge could not be openly shared. According to Klaus Hjuler this could be frustrating for both the PhD students and the FLSmidth staff involved. The PhD student would not be able to get feedback on his research from qualified people with real-life experience, and FLSmidth staff would not get an insight into the new knowledge generated in the collaboration they are partners in.

Thomas Hørup, innovation facilitator, mentions that FLS is actively working with universities and seeking industrial partners for research collaborations. Both divisions of FLS; cement and minerals, are actively looking at collaborations with external partners.

Thomas Hørup believes that knowledge sharing is taking place with university partners like DTU to the extent it is necessary inside the specific project area. He also believes that there is a need for caution when sharing knowledge that could be seen as confidential. The biggest challenge in terms of knowledge sharing with external partners according to him is confidentiality and to some extent IP concerns. Knowledge is one of the most valuable assets of the company and needs protection.

We are a knowledge intensive company and knowledge is what we make our living on. So of course we protect it and take of care it so it's only shared with those who need it. So it is our most, one of our most valuable capitals is our knowledge. So in that sense we keep it to ourselves. (Thomas Hørup)

On the issue of internal knowledge sharing, Thomas Hørup also believes that it is a serious challenge that has been recognized as such and steps are being taken to address the challenge. The attempt is to find a balance where knowledge is shared with the right people in the right amount. Not too much so that it creates a risk, but also not too little.

Among the practices mentioned regarding knowledge sharing internally, there are the lead specialists, people who are recognized as having special skills and are trained and encouraged to build interpersonal networks with other lead specialists. The lead specialist's role is to serve as a knowledge sharing hub within their area in the organization and also maintain a global network of other specialists. Besides the lead specialists, there is also a R&D portal for sharing knowledge on different research projects. R&D employees have access to this information, but to be able to utilize it, it requires that they are aware it's available and know where and how to find it. At the moment there is no data on how well these are functioning and to what extent knowledge is being shared.

Knowledge sharing between the R&D unit and other units of the organization, some in different geographical locations, is another tricky challenge. Employees in R&D have access to information but those outside by default do not. As of now the focus on knowledge sharing is primarily within the R&D department and not so much with the rest of the organization.

So I think it's very difficult, also from where in the organization you are. Some parts of the organization you simply are seen as not needing to be involved in the sharing of information. (Thomas Hørup)

7.4.4 Part Summary

Of the four types of network mentioned by Grodal (2005); informal networks, project networks, regional networks and business networks, FLS uses informal networks and project networks. Informal networks such as European Cement Research Academy (ECRA) play an important part in the exploratory open innovation approach adopted by FLS. The ties with ECRA are weak compared with the ties with DTU. Weaker ties according to Grodal (2005) are more critical in passing new and different ideas from new sources. Once there is awareness of these new ideas, those most beneficial for FLS can be identified and partnership established. Over time such weak ties, can become strong ties once a formalized partnership is established.

Similarly when engaging other firms for short term projects, over time as trust is established with those firms, and a common ground developed, a more formalized relationship can be founded. To attain broader benefits from an exploratory open innovation approach, it is important that the development department and is also included in the process, and short term projects also be considered, and not just focus on the research department and longer term projects.

Project networks, is another approach used by FLS. The NCTP platform with DTU can be characterized as a project network. FLS has other similar projects networks with DTU and other universities and with some other firms. The strong ties that exist between FLS and DTU are special and have been built over many years. FLS provides research funding to DTU, and employs many DTU graduates. Therefore it's easier for

both sides to engage in collaborations without spending massive amount of resources and time on legal issues. Formal ties are preferred by FLS as the interviews show. Formal ties are based on a contractual framework which acts as a safety net. According to Grodal (2005), Vinding (2002), Godoe (2000), Ahuja (2000) networks with formal ties between the partners and high level trust due to those ties, lead to higher level of innovation as compared to informal and indirect ties. The closed knit networks based on a formalized framework provide a better basis for knowledge transfer.

At the inter-organizational level, FLSmidth uses long-term research collaborations with partners that have been able to establish a relationship with FLSmidth. Contracts are used to establish a formal setting and ground rules for the collaboration. Looking at the variables for inter-organisational cooperation described by Brass et al. (2004), the motive for NCTP collaboration is that it gives FLSmidth access to resources such as knowledge and researchers from a leading university DTU, and funding from the Advanced Technology Fund. DTU gets access to an industrial partner that is a market leader and has equipment needed for industrial scale research, financial resources, along with past cooperation history with DTU. Both have a similar status as leaders in their field, and the new partner Hempel is also a leading firm within their industry. The trust factor is important for FLSmidth and norms reciprocity, which plays an important role, particularly when having to settle disputes. The historical ties between FLSmidth and DTU, a similar culture, are significant factors in developing inter-organisational ties, as is the convener role played by Advanced Technology Fund.

Such close inter-organisational ties can lead to high information flow between the parties, increasing the possibility of imitation of work practices. When PhD and post doc students are transferring knowledge between FLSmidth and DTU, the close relationship helps to enhances diffusion of knowledge. The diffusion is also enhanced by the social links, as many FLSmidth employees are DTU graduates, and the managers feel more comfortable with engaging a similar organisation.

Research suggests that when organisations are not direct competitors and are in a formalized collaboration, increase sharing of knowledge and innovative output. Brass et al. (2004). The FLSmidth and DTU inter-organisational relationship enables knowledge sharing beyond the framework of the NCTP platform, at multiple levels. When knowledge sharing is done in a formalized collaboration, and if it is fast and at multiple levels, it has a positive effect on innovation and patent output.

As Brass et al. (2004) point out that inter-unit ties play an important part as connecting link between inter-organisational level ties and inter-personal ties. In FLS the inter-unit ties between FLS cement and mineral division R&D are at a low level. There is very limited interaction between the divisions. Similarly among the

departments, interaction is limited, the only exception being the process engineering departments that has a high level of inter-unit cooperation. To enhance the ties between the units, there has to be incentives that encourage cooperation, and also awareness of the resources available in other units, and how those resources can be shared among the units. This will require intervention from the top to create incentives and also give the units space to make the necessary allocations of resources for inter-unit cooperation. Inter-unit ties influence innovation and knowledge sharing activities. Units that are centrally placed in inter-unit networks, have higher innovation. Increased level of inter-unit cooperation will improve the units and the organisations performance.

As the answers from the participants suggest, FLSmidth uses different models for collaboration with different partners. The main model used is partnership with universities on longer term research projects. In the development department there is no similar collaboration setup, more short term engagements based on immediate needs that vary from project to project. The bulk of collaborations with external partners take place in the research section and it is the trusted partners that figure most often in the collaborations. Engaging in short term collaborations, risks that a lot of time is spent on legal safeguards before commencing the collaboration and during the collaboration on safeguarding IP, leading to both sides not being able to openly share ideas.

Interpersonal ties are the basis of inter-unit and inter-organisational ties. Actor similarity increases interaction, and fosters trust. Employees with similar backgrounds will find it easier to network and share knowledge Brass et al. (2004). The links many FLSmidth employees enjoy with DTU helps create relationships between the organisations, and the fact that many FLSmidth employees are DTU graduate, and mostly engineers, also helps foster inter-personal ties. As the interviews have shown there are some areas where inter-personal ties are strong, and the role of lead specialist in promoting inter-personal ties can go a long way in terms of knowledge sharing between people. It's important to note that proximity also enhances interpersonal ties. When a firm like FLSmidth is spread globally, there is perhaps a need for organizational structures, work flow and processes that encourage non-proximate employees to also develop inter-personal ties. This might be seen as costly, but once ties have been established, they can be maintained using electronic communication. Employees will then be able to themselves maintain relationship they see as beneficial. As there is currently no database where knowledge sharing can happen across FLSmidth, interpersonal ties are important in establishing connections between different groups of employees.

As Vesamäki points out for the future it is important for FLSmidth to engage more and different partners. The focus on longer term partnerships suggests that the experiences from DTU, such as a long term

partnership with mutual trust, has had its benefits, and for the future FLSmidth will be looking to emulate that by finding similar partners with whom it can establish a similar partnership.

The interviews and research conducted for this paper has shown that it will be difficult to use the FLSmidth's relationship with DTU as a model for future collaborations with new partners, as the deep history and common ground developed by FLSmidth and DTU over the years is difficult to replicate. This could be the reason that FLSmidth has not been able to establish a similar strong relationship with another leading academic institution.

The types of engagements mentioned by Kimmo Vesamäki for future networking, shows that there is a strategic vision of engaging different partners beyond those currently used, which can open up more possibilities than having a narrow approach only directed towards one focus area. It is important to also include informal ties to the strategy in a meaningful manner, as the informal ties even with their limited effect on innovation as compared to formal ties, can help create links that can develop over time into formal partnerships. As a large firm at the forefront of R&D in its industry, maintaining high level research ties with top universities like DTU, increases close contact with researcher and foster interpersonal ties and the absorptive capacity of FLSmidth.

8. Discussion

The discussion will begin by looking at macro level challenges, which influenced the Horizon 2020 process, and shifted the EU's institutional logics from a science-logic towards a market-logic. The challenges and implications of this shift and the suitability of Horizon 2020 to address them will be discussed, leading towards some recommendations for the EU.

The micro level will discuss FLSmidth and the challenges facing FLSmidth and how collaboration, open innovation and access to public funding can benefit FLSmidth. Key issues identified in the analysis will be discussed, and recommendations on how FLSmidth can utilize Horizon 2020 to strengthen research and innovation will be presented.

8.1 Macro level

Horizon 2020 is a large programme and a necessary one, when looking at the internal and external challenges facing the EU. There is a marked difference from FP7 in terms of funding for Horizon 2020, the merger of several programmes and creation of a simplified structure for those applying for funding. The simplifications in the application process, the call structure and increased digitization due to online applications, could ease the application process.

The size of the programme might be bigger than past programmes, but the combining of several programmes into one, inflationary pressures, increasing the pool of applicants, make the increase smaller in real terms. The original proposal by the EU parliament of € 100 Billion, compared to the € 80 Billion approved, might have been more adequate.

Many universities and research institutions that have been part of the EU funding system in the past are dependent on the funding they receive from the EU. Firms also increasingly require access to public funding, as other commercial funding options might be limited. In a crisis-situation where the national governments are cutting expenditure, credit hard to get, there is a need at the EU level to ensure adequate funding for top universities so they can compete globally in the years to come and provide cutting edge knowledge to firms. The massive regional differences among the member states with regards to research and innovation also make a case for increased EU funding to ensure less resourceful regions are not left behind. The EU as a whole needs to be steered towards a knowledge-based economy and for that to happen, EU level coordination will be needed.

Knowledge economy is a “buzz-word” that has been around for a while now, but a precise definition is still elusive. The amount of people working in knowledge-intensive industries can be used as a starting point. Some member states are doing well in this regard, while others are clearly lacking. For the EU as a whole to move forward and face the external challenges, Horizon 2020 needs to be large enough to give the best-performers the resources needed to maintain their position, and also give those lagging behind support to become better and not be left behind. This should not be seen as a case for promoting mediocre research, but as a case for optimal use of all available resources. Research has shown, public funding for research and innovation does have positive effects on society and helps in growth and job creation if applied correctly.

A few high-tech clusters in northern EU will not be able to lift the entire union out of the crises and ready to face challenges from the US, China and others. The old industries have also not been able to tackle the challenges facing the EU. Therefore to secure growth, jobs and tackling environmental and health related challenges, research and innovation are critical. In the short and mid-term supporting the old industries via the industrial leadership pillar might be a good idea, but for long term growth and prosperity, more investment in science excellence and societal challenges is needed. Even for the old industrial sectors to remain competitive, new technologies are necessary when competing against firms from regions with lower wages and costs, and in some cases direct government support.

The level of funding provided by Horizon 2020 should be seen as a minimum. Currently the EU and the US have similar GDP, but the US spends 2.8 % of its GDP on R&D, Japan spends 3.3 %, South Korea 3.4 %, while

the EU spends 1.9 %. China is also increasing its R&D spending, and in 2012 they spent 1.96 % of GDP (Ramskov, 2014). The European Round Table of Industrialists and the European Research Council (ERC) have strongly advised against further cuts, stressing the need to maintain the budget at € 80 Billion (Johansson, Nowotny, Löscher, & Hunt, 2013). University groups, such as the Russell Group, UK, share the view of the ERC and Industrialist (Cookson & Cook, 2013). Other lobbying groups have also pressed the EU for not cutting the R&D budget any further, as it would have a very negative impact on growth, and hinder recovery of the economy (Wickham, 2012).

Considering the increasing role of knowledge in the global economy, there is definitely a need for the EU to clearly signal that research and innovation are a top priority. In the current budget passed by the EU for 2014-2020, Horizon 2020 accounts for less than 8% of budget, while agriculture and rural development account for approx. 40 % of the budget. There is a clear need for the EU to re-prioritize and seriously re-look at the internal and external challenges, and make more funding available for research and innovation in the future.

While funding is one part of the process, the EU should be clear in developing a policy approach with the involvement of member states, to ensure that EU funding through Horizon 2020 is able to steer the Union towards a knowledge-based economy. It is again a matter of prioritization. Research and innovation should be given higher priority than agriculture and old industrial sectors. These sectors might retain some jobs, but for long-term job creation and retention, new technologies are needed that can change or create new markets.

An EU led approach could reduce internal competition between the member states, decrease duplication of efforts, and provide better use of limited funds. For this to happen the calls structure of Horizon 2020, needs to work as planned in the vision behind Horizon 2020. The member states would also be required to utilize domestic resources in a manner that enhances research and innovation, and supports organisations that participate in EU programmes. The increased competition for EU funding under Horizon 2020, will be a challenge and member states should be willing to provide domestic funding options for projects that are unable to get EU funding. The Danish Advanced Technology Foundation is an example.

The funds that have been earmarked for Horizon 2020 need to be utilized optimally. For that to happen, the calls structure needs to fit the task. The simplification promises and the time-lines set for project evaluation must be kept. Researchers should be able to get funding without spending their already scarce funds on a huge bureaucratic process, with limited chances of getting the funds. To make Horizon 2020 more attractive for a larger part of the research community in the EU, simplification, reduction of bureaucratic hurdles and

ensuring timely processing are a must. If the EU is able to achieve this, then firms like FLSmidth, which in the past have not seriously considered accessing EU funds, will be tempted to enter the process.

A larger pool of potential participants will make it possible to find the most suitable partners. The option for international research is also a welcome addition, as a lot of research is conducted across borders, and it's important for EU researchers to be able to access knowledge in other parts of world, by collaborating with partners outside the EU. Firms will also be more attracted to enter the process if the best players are in it. Involvement of firms is what marks a major shift in Horizon 2020 from previous programmes, therefore attracting firms to enter the process should be a priority, and efforts made to ensure it happens.

Recommendations for the EU:

- The funding level for Horizon 2020 must be maintained, or preferably increased in future framework programmes, to ensure adequate funds for universities and firms.
- The promised simplifications in Horizon 2020 application process must be ensured and the timelines met. All efforts should be directed at ensuring a smooth process that gives quick access to funding for researchers.
- If the anticipated teaming up of firms and academia in Horizon 2020 collaborations does not occur within a reasonable timeframe, or firms and academia encounter other challenges which decreases their interest in seeking Horizon 2020 funding, the EU must show flexibility and quick response in addressing those concerns and finding solutions immediately.
- The level of coordination between the EU, national and regional governments, must be increased to ensure a structured and united approach towards the internal and external challenges. Otherwise internal competition and duplication of efforts might weaken the EU.

8.2 Micro Level

For Horizon 2020 to be successful and tackle the challenges facing the EU there is a need for active involvement of academia and industry. In past framework programmes there has not been much focus on industry participation. With Horizon 2020 the EU seeks to change that. The new approach attempts to increase industry participation in research and innovation. This new approach provides a window of opportunity for firms like FLSmidth that have an excellent R&D structure in place but are mainly functioning within the national setting. For firms like FLSmidth to be able to address future challenges and budgetary constraints, access to public funding is important.

In the past public funding has proven to be an important tool for FLSmidth in setting up prototypes and accessing new technologies. There have also been cases in FLSmidth where the lack of public funding has

impeded further research in promising new technologies. The NCTP platform with DTU has shown that FLSmidth is able to participate with external partners in a publically funded project. The addition of a new industrial partner, Hempel A/S, will add knowledge and experience to FLSmidth, which can be helpful in future collaborations.

The challenges facing FLSmidth in maintaining a world class R&D, call for a broader approach to collaboration. For FLSmidth to maintain its current position requires substantial and continuous investment in R&D to develop radical and strategic innovations, which can be a time and resource consuming endeavour. At the moment the internal target of spending 2 % of revenue on R&D, has not yet been met, and there have recently been significant layoffs across FLSmidth. Seeking public funding and access to external resources by collaborations should be carefully considered as a way of maintaining the leading position in the industry when internal resources are limited.

The strong ties that FLSmidth has with DTU and other Danish universities are a strong and valuable asset, but to get access to new ideas from new sources, FLSmidth will have to venture out and locate new partners. To reach that point, there needs to be a knowledge and experience building process that gives FLSmidth the opportunity to work with some of the best European and global researchers or organizations. An exploratory approach will be best suited, where FLSmidth is able to locate and develop ties with industry leading partners, and use the process to identify the most relevant partners for the development of stronger ties. The weaker ties should be regularly maintained. If and when a problem appears, the weaker ties can be used to locate potential partners for collaboration on solving that problem. If the weaker ties are not maintained, FLSmidth may not be able to locate relevant external partners.

From the perspective of firms like FLSmidth, Horizon 2020 provides a valuable source of funding and a simplified application process will make it easier for firms to evaluate how many resources will be needed for the application. The fixed time-lines will give firms a time-frame they can use to plan their activities.

For FLSmidth the participation in publically funded collaborations in the past has brought in a lot of experience which could be utilized for seeking EU funds. It will not be a case of re-inventing the wheel. Horizon 2020's approach on increased links between academia and industry, and its focus on cutting edge research make it an attractive proposition for FLSmidth.

For a research and innovation strategy to be effective, FLSmidth and other firms in the EU need to have a clear understanding of Horizon 2020, and its overall objectives in tackling the external and internal challenges facing the EU. Without such an understanding, getting EU funds will be difficult as the funding is aimed at projects which can help the EU fulfil its goals. FLSmidth should therefore study the EU objectives,

and form a strategy for Horizon 2020 funding which takes that into account. National and regional funding opportunities should also be utilized where possible. According to EC data, applicants that are successful in getting EU funding are also more successful in getting funding from other sources. The triple-helix approach of engaging governmental agencies, academia and industry, should be a suitable model for FLSmidth as it resembles the NCTP collaboration platform, involving FLSmidth, DTU and the Advanced Technology Foundation. The public institution provides funding and an institutional framework for collaboration, the academic partner provides access to researchers and cutting edge knowledge and the firms provides market knowledge and commercialization prospects.

Since the first round of calls is already under way, the best strategy for FLSmidth will be to study the process, analyse the calls structure, the mechanisms, and design a strategy for taking part in the next round of calls, and locate and approach potential collaboration partners. There will be strong competition for Horizon 2020 funds, due to simplification of the application process, high amount of funding available, and many firms and universities facing budget constraints. It is therefore crucial that the research proposal fits into the EU's vision.

One of the main areas previously holding FLSmidth back from applying, has been IP concerns. Horizon 2020 does provide safety mechanisms for IP, but that might not be enough for FLSmidth. As such the optimal solution for FLSmidth would be to utilize EU funding for research that can be classified as frontier research and is far away from market entry. Focussing on such research will reduce the risk to FLSmidth's current and close-to-market technologies, while providing FLSmidth access to future and emerging technologies. Besides access to new technologies, working with partners who are leaders in their fields, will provide FLSmidth with new knowledge and opportunities to apply new perspectives to old knowledge, which is an important aspect of the open innovation approach.

The leading position of FLSmidth in the cement and minerals industry, the strong R&D profile and strong ties with DTU will make it an attractive partner for other firms. But for FLSmidth to be fully able to reap the benefits of collaboration and open innovation there needs to be internal adjustments that ensure more knowledge transfer. Currently the closed-innovation approach, which has dominated the company for decades, is preventing FLSmidth from being able to benefit from open innovation. If FLSmidth improves the intra-firm knowledge sharing, for example by creating stronger links between the cement and minerals divisions, and other global units, the knowledge available within the company can be better utilized. The current reliance on inter-personal ties is not adequate, and more should be done to improve inter-unit ties, so that there is more knowledge-sharing across the different units. For starters, the cement and minerals division could map out areas where collaboration could be mutually beneficial.

If FLSmidth does not adapt internally, there is a risk of not being able to utilize the external knowledge the company is able to access in collaborations. In such a scenario, a lot of valuable time and resources will be spent on a process that does not bring adequate rewards. The collaboration process is complicated, time consuming and to reap the awards, the company has to be able to filter the knowledge and absorb what is relevant for it. Silo-thinking and not-invented-here type of thinking can be a major stumbling block. Therefore a culture change might be necessary to be able benefit from collaborations and open innovation.

Recommendations:

- FLSmidth should take part in EU funded collaborations, to gain access to funding, external resources and develop new ties with potential future partners.
- FLSmidth should consider the open innovation approach, and locate areas where external resources could be beneficial and find relevant collaboration models to access those external resources. The business model should be developed so that old knowledge such as unused patents, can be used in new ways to increase revenue and growth.
- Knowledge sharing should be improved both internally and externally to ensure adequate benefit from collaborations. Similarly cooperation between the different units should be increased, so in-house resources are best utilized.
- The absorptive capacity of FLSmidth should be maintained or enhanced. If the internal absorptive capacity is weak, due to lack of in-house expertise, FLSmidth will not be able to gain full advantage of collaborations.

8.3 Part Summary

Both the EU and FLSmidth need each other. The macro level discussion has shown that the success of Horizon 2020, and its ability to address the major challenges facing the EU, depends on increased participation of firms in the research and innovation process. Firms are the critical link between research and commercialization. Firms have to be more actively involved if the institutional logics shift at the EU level from science-logic to market-logic is to be successful.

Similarly at the micro-level, FLSmidth will not be able to enhance R&D capability without accessing public funding. Currently national level funding options have been utilized, but in a competitive market setting, there is definitely a need for accessing EU level funding and developing partnerships with leading universities across the EU, while maintaining the current strong ties with national universities. Horizon 2020 provides the best framework for FLSmidth to access EU funding and develop new partnerships.

9. Conclusion

This paper has shown that Horizon 2020 can potentially tackle the challenges facing the EU to some extent, but perhaps more could have been done. Although the amount of funding for Horizon 2020 is an issue, if the current level can be sustained, or preferably enhanced by member states own funding in the coming years, it could have a significant impact as public funding for research leads to higher growth. In the current scenario with tight fiscal discipline being advocated in most member states, that seems unlikely.

The utilization of the programme will determine if it is adequate or not. The external challenges facing the EU, the rise of the emerging economies and their investment in R&D, and the R&D capabilities of other leading economies like the US, Japan, South Korea, etc. are major shifts that have been happening over decades, and will continue to develop in the coming years. Similarly the internal challenges such as environment, health, security, energy, etc. are also developing challenges. To address these challenges, flexibility from the EU will be important. If the knowledge which formed the basis of these decisions is changing, the response also has to be flexible and able to change to meet the new realities. If for example firms are not finding Horizon 2020 attractive enough, or if universities are finding it difficult to locate relevant commercial partners, and as a result their research gets delayed, the EU will have to react quickly. Waiting till the commencement of the next framework programme to adjust, might be inefficient and could result in Horizon 2020 not being able to fulfil its goals.

The clean break from past programmes was necessary and shows an important sign that Horizon 2020 is a new way of approaching these challenges, and that better integration of firms in the research and innovation process can improve the time from idea, invention to market. To gain full benefit of this approach, firms must be integrated into the research and innovation process. For firms to enter this process, the EU decision making process would have to show more responsiveness and quicker decision making. A process that is time-consuming, bureaucratic and complex might deter firms from taking part in Horizon 2020, if found too deviating from the processes that occur inside firms.

For firms in the EU, like FLSmidth, Horizon 2020 provides new funding and research possibilities. To access and take advantage from EU funding a comprehensive research and innovation strategy will be needed. Open innovation practises need to be looked at closely, and incorporated where possible and key collaboration partners identified for future research. Internally the firm needs to be skilled and experienced to take full advantage of collaborations with external partners. If the firm is not able to absorb external knowledge, and then share that knowledge internally so it becomes available where necessary, the collaboration process might not yield the desired results. Knowledge sharing and absorptive capacity are two key focus areas for firms wanting to be successful in collaborations.

There is definitely scope for more research into both the macro level implications of EU's research funding shift from a science-logic towards a market-logic and micro level implications for firms like FLSmidth. The benefits of closer firm involvement in the early stages of research are also an area that needs further research, and how focus on increased commercialization of research impact fundamental research. Fundamental research might not have a direct commercial application today, but for long term growth fundamental research is critical.

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Main sources for Horizon 2020 related information and data:

http://ec.europa.eu/programmes/horizon2020/

https://ec.europa.eu/programmes/horizon2020/node/119

11. Appendix

Figure 1: Environmental R&D, 2004 – 2009.

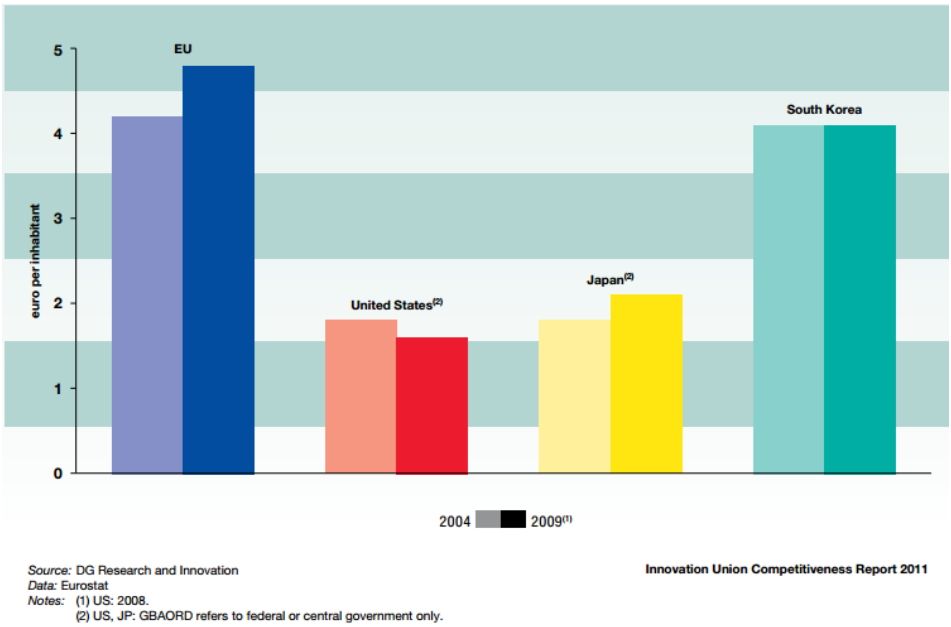
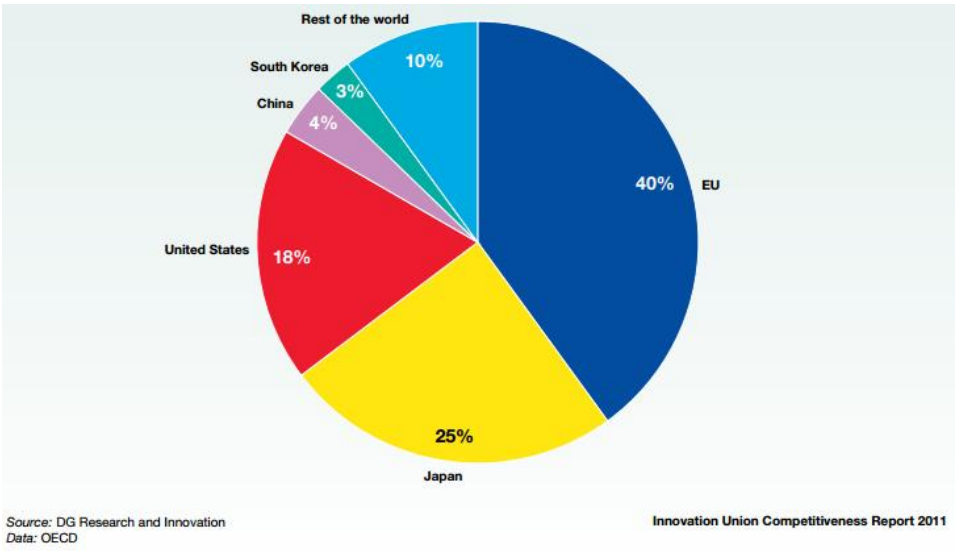


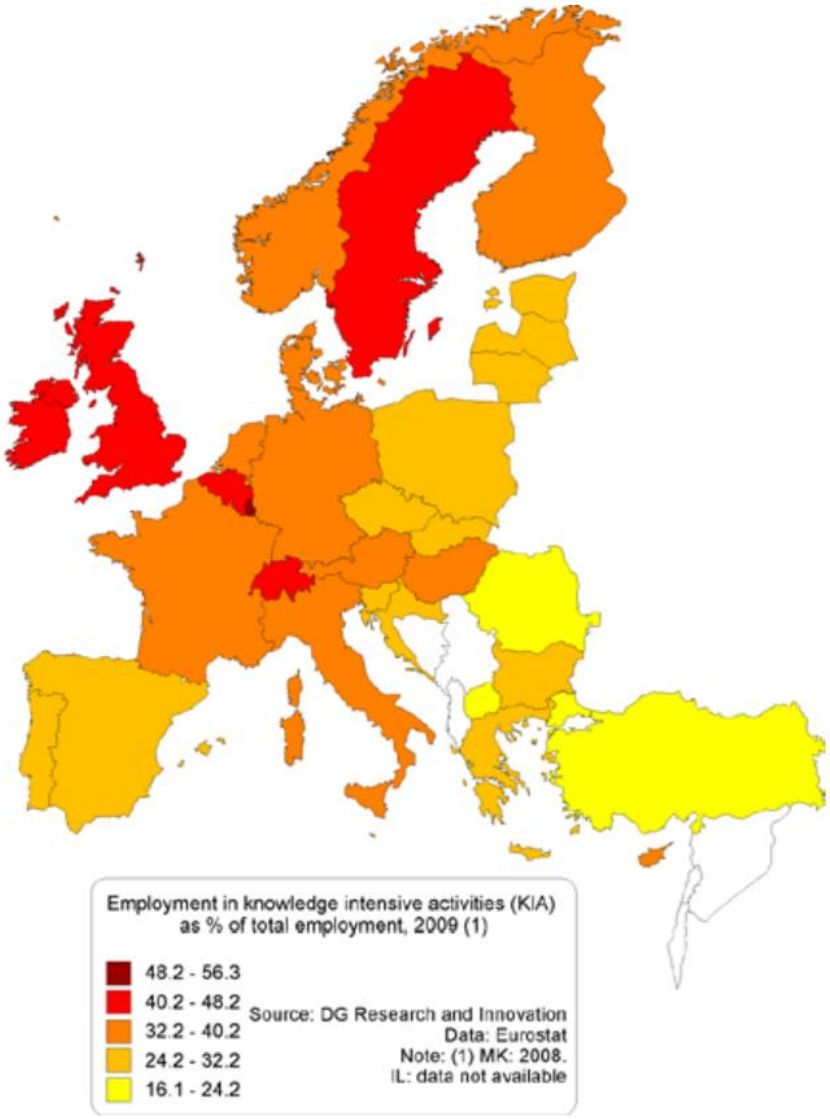
Figure 2: Climate Change mitigation technologies – PCT patent applications, 2007.



Source: Innovation Union Competitiveness Report – 2011 Edition (page 414 & 416)

http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011/iuc2011-full-report.pdf#view=fit&pagemode=none

12. Figure 3: Employment in knowledge intensive activities.



Innovation Union Competitiveness Report – 2011 Edition (page 381)

http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011/iuc2011-full-report.pdf#view=fit&pagemode=none