Commercialization of results in research public-private partnerships.
A study on the influence of project characteristics on commercialization in the 7th framework programme

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Abstract

In Europe the industrial performance is lower than the scientific performance. There seems to be a gap between scientific exploration and commercial exploitation. The European Commission steers towards more applied research in order to stimulate commercialization and continued that line when introducing a public private partnership structure (PPP) within FP7 in 2009. This study focuses on commercialization of results of research and innovation projects. The focus is on project characteristics that hinder or stimulate commercialization. To answer this question 10 case-studies are performed of projects that fall within this PPP structure, these projects are expected to commercialize project results. We found that when projects are intended to commercialize project results, they should be small of scope, include value chain partners and end-users, and use technology that is mature enough to expect a commercially viable results at project end.

Keywords: Commercialization, Collaborative project, Innovation, Europe, FP7, Valley of Death

1 Introduction

Back in 1995, the European Commission identified that the industrial performance is low compared to the scientific performance in Europe (European Commission, 1995). This is called the 'European Paradox' by the European Commission. Recent European Competitiveness reports of 2011 and 2013 shows that the industrial performance is still lower than the scientific performance (European Commission, 2011, 2014), meaning there is room for improvement in this area.

This European paradox has been criticized by Dosi, Llerena, and Labini (2006), they came to the conclusion that the 'excellent' scientific performance of Europe was not that excellent. Compared to the United States, the scientific performance is equal or lower in Europe, depending on discipline (Dosi et al., 2006). They also mentioned that the European paradox assumes a linear path from scientific exploration to commercial exploration. This is not always the case, scientific exploration is not always the source of innovation (Dosi et al., 2006). While this criticism on the European paradox is valid, it is still true that the scientific performance is higher than the industrial performance. In this article it is acknowledged that the source of innovation is not always linear, but it *is* a way innovation occurs.

The European Commission, in recognition of this paradox, steers towards more commercialization of research results by shifting their programs from basic research to more applied and development research in order to stimulate commercialization of research results (European Commission, 2007b). In 2009 this strategy was continued by the addition of the Public-Private Partnership structure to the 7th Framework programme as a reaction to the economic crisis (European Commission, 2013a). This PPP structure aims to strengthen industries that were hit severely by the economic crisis. The PPP structure is focused on participation of industrial partners and on stimulating the commercialization of project results (European Commission, 2013b).

In this article we explore whether this research strategy is contributing to lifting the European Paradox by looking at the characteristics of research and innovation projects and their influence of commercialization of project results; **what characteristics of research and innovation projects stimulate or hinder commercialization of project results?**

To answer this question the cause of the problem, commonly referred to as 'the Valley of Death' will first be explored in section 2. Also in this section the literature will be explored for factors influencing research and innovation projects, at the end of the second section, factors that potentially have an influence on commercialization are presented. In section **Error! Reference source not found.** the methodology to find factors of influence from empirical data are presented. In section 4 the results of the study are summarized by presenting the project characteristics that influence commercialization strategies within European FP7 public-private partnership projects. This article ends with a conclusion & reflection in section **Error! Reference source not found.**.

2 Literature Review

The problem introduced in the first section is commonly referred to as the 'Valley of Death'. The Valley of Death is a term for the troublesome transition from technology researched and developed into marketable

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

In literature there are several authors who position the Valley of Death at different stages of technology development. Auerswald and Branscomb (2003) place the valley between invention and development, where research is no longer purely scientific. Murphy and Edwards (2003) place the valley on the stage of product development, slightly later than Auerswald and Branscomb (2003). The House of Commons: Science Technology Committee (2013) placed this valley at the prototyping and scaling-up phase, whereas the High-level Expert Group (2011) of the European Commission on Key Enabling Technologies placed the valley from basic research all the way to commercial exploitation. The most common place of the Valley of Death is after the proof of concept is given and validated in a lab environment. After this phase further development, prototyping and scaling-up is needed. This definition is used in this study: the Valley of Death is the phase after scientific discovery, when the technology is validated in a lab environment and ends when the technology is ready for commercial exploitation. In this research we look at commercialization of project results. This definition suits these projects, as commercialization requires technology that is already in a development phase.

To overcome this Valley of Death in Europe, technology should reach the market. The projects should be designed in such a way that the technology is more likely to reach the market. Therefore in the following sub-sections the literature is explored on project characteristics that affect research an innovation projects. Exploration of these characteristics can support the European Union in the design of EU-funded R&D projects in such a way that the Valley of Death is more likely to be crossed at the end of the project, by commercialization of the project results.

2.1 The effect of characteristics of research and innovation projects on the projects

In this section the literature is explored on characteristics that have an influence on research projects. Collaboration in research projects increases productivity (publications and other outcomes of research in relation to the time and resources spent) of the researchers (Landry, Traore, & Godin, 1996). This is true both between academia and between academic and industrial researchers. Godin (2003) found that the amount of funding positively correlated with the productivity. This is because it provides access to more and better research resources (Lee & Bozeman, 2005). Collaboration also increases productivity because a single researcher does not have all the knowledge and skills required, other project members have different knowledge and skillsets (Katz & Martin, 1997). One of the aims of the 7th framework programme is focused on bringing together resources for high-end research needing multiple different research disciplines not available on a national scale (European Commission, 2007a). Literature on research collaboration focusses mostly on easy to measure output such as patents and publications. There is a gap in the literature concerning commercialization of results in these collaborations, specifically when both research and industrial partners are involved. In short, collaboration and increased funding have a positive effect on the research projects.

Barbolla and Corredera (2009) investigated factors leading to success and failure of research projects, the authors analyzed collaborative projects and contract research between university and industry by performing interviews with university researchers. Barbolla and Corredera (2009) found that projects need to have a clear scope and clearly defined roles of the participants from the beginning. Including numerous stakeholders in the project however, makes the project less likely to succeed. This is due to objectives being different, a too heterogeneous group of actors or difficulties with managing the project. Furthermore, Barbolla and Corredera (2009) found that the amount of funding coming from the participants increases project awareness, in turn increasing the chance for project success. Triggers for project failure were technical difficulties, insufficient funding, inadequate human resources and unclear project definitions. The objectives were not feasible

from the start because the technology used was uncertain or too immature. In short, a clear scope and a large amount of participant funding have a positive influence on research projects and technological risk. While technological high risk or immaturity, inadequate project management and too many partners have a negative effect on research projects.

2.2 Partner influence on research and innovation projects

The influence on partner diversity on research and innovation projects is also covered in previous literature. Partner diversity has a positive effect on projects when research partners share the same basic knowledge (Petruzzelli, 2011). When partners do not share basic knowledge or share knowledge on a specialized level, the collaboration is less effective (Petruzzelli, 2011). Partners involved in a research and innovation project operate in the same value chain, thus sharing the basic knowledge, have a positive effect both on the project and commercialization of results (Raesfeld, Geurts, Jansen, Boshuizen, & Luttge, 2012).

Industrial firms are also more likely to collaborate with clients and suppliers to pool resources and better innovation efforts (Miotti & Sachwald, 2003). However when direct competitors are involved the effect is negative (Nieto & Santamaría, 2007). Although competitors can work together effectively on basic research, standardization or other activities that lie beyond a single company's influence (Nieto & Santamaría, 2007). Lastly Nieto and Santamaría (2007) found that collaboration between research organizations and industrial firms is also stimulating project success and noted that collaboration with diverse partners is a success factor. Prior research also indicated that SMEs benefit the same way from collaboration with value chain partners and research organizations as large firms (Zeng, Xie, & Tam, 2010). In short, collaboration with partners from the value chain and partners that have the same basic knowledge has a positive effect on a research project, while having competitors in a project has a negative influence on @...

2.3 Influence of consortium composition on commercialization

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

2.4 Summary on literature review

There is little literature on the effect of project characteristics on commercialization of results of research and innovation projects from the perspective of research partnerships. Therefor we used the literature review to explore factors that may have an effect on the commercialization of results. We came to the following basic inventory:

Factors that positively affect projects are:

- Collaboration
- Amount of Funding
- High participant contribution
- Clear scope and clear roles
- Inclusion of value chain partners
- Non-profit/medium sized lead partner

Factors negatively affecting project are:

- Technological immaturity
- High Technological risk
- Inadequate project management
- Large number of partners
- Working with competitors

These factors were the starting point of our study, in which we searched for characteristics of research and innovation projects that have an influence on commercialization of project results. These will be used as input for the case-studies described in the next section.

3 Empirical evidence

We found characteristics from literature that might be of influence on commercialization. These characteristics are now researched in the cases. The research question in this study is: what characteristics of research and innovation projects stimulate or hinder commercialization of project results? To help answer this question

10 case studies are performed on research and innovation projects that received funding from the European Commission

3.1 Motivation for case-study research

Case-study research is used because the project is exploratory in nature and in a relatively unknown domain. This study has ties with the FP7-NMP evaluation performed by the Technopolis-Group, in which 51 case-studies will be performed, of which 10 are used for this research. According to Yin (2009) case study research is suitable when a study emphasizes on key mechanisms, where the researcher cannot control the outcome and when the research is done on current issues. Yin (2009) also identified drawbacks of the case study approach. The first is the lack of rigor; the case study researcher needs to ensure that his results are not subject to bias. This is dealt with by interviewing persons from both the research side and the industrial side and interviewing the project coordinator who has an overview of the project. Furthermore, it is hard to generalize results to all projects based on a case study, by doing 10 different case studies this drawback is minimized.

3.2 Sources for the case study research

This study is tied to the Nanosciences Nanotechnology, Materials and new Productions theme of the 7th framework programme (FP7-NMP in short) evaluation, this means we had access to unique sources of information, most of which are confidential. Downsides of this are that this study can only report on an aggregated level and that the data collected does not solely focus on commercialization of project results. For this study access is provided to the Grant Agreement of FP7-NMP projects. This document gives information on, goals objectives, expected output, expected impact, planning, partners and funding. For a large number of projects a review report is available which gives information on: progress, resource utilization, collaboration and potential for commercialization. For each project 2 or 3 interviews were performed where interviewees are asked about: project progress, challenges, output, impact (scientific, technological and economic), project formation, project collaboration and commercialization (plans). To attain a complete overview of each project, one interviewee has to be the coordinator, one interviewee has to be research oriented and one interviewee has to be industrial oriented.

3.3 Sampling the cases

799 projects received funding from FP7-NMP. For the evaluation of this programme, the sample needed to cover the entire scope. In order to do this the projects where characterized by theme (there are 7 themes within the programme), funding-scheme (defines scope of the project) and technology readiness level (TRL, a 9 point scale which indicates the maturity of the technology that is subject to the research and innovation project, 1 is when basic principles are observed and 9 is when the technology is ready for commercial exploitation). When a combination of funding scheme and theme included more than 10 projects, two samples are drawn of different TRL. When a combination has between 4 and 10 projects only one sample is drawn. All projects were quickly checked for information availability, and were replaced when little or no information was available. This resulted in an ultimate sample of 51 projects of which 10 were specifically used to explore the influence of project characteristics on the commercialization of project results

We selected 10 projects with a high technology readiness level as this increases the chance that at the end of the project the technology is (nearly) ready to be commercialized and thus can inform us on the commercialisation strategies used. This is important for this study, if we use projects that have a low TRL, it is less likely that the technology is ready for commercialization at the end of the projects. Furthermore the project should have industrial/private parties participating in the project, as they are more likely than public partners to commercialize results of the project. The PPP structure is most fit for this research as it focuses on strengthening their respective industries, by introducing new technologies. In other words these projects focus on technologies that at the end of the project are expected to be ready to be commercialized. The nature of the public-private partnerships also ensures that the participants of the project are always a mix of public research and industrial partners. Including industrial partners ensures that there are partners that at least have a commercial goal, thus increasing the chance that results are being commercialized at project end.

The PPP structure is split into three themes: Energy Efficient Buildings (EeB), Factories of the Future (FoF) and Green Cars (GC). It became obvious that the Green Cars PPP was not fit for the purpose of this study as the sampled projects were of a low TRL (3-4) and focussed mostly on technologies for new types of batteries. The documentation provided for these projects showed that at the end of the

project, the technology was probably not ready to be commercialized. The projects in the EeB PPP and FoF PPP are more diverse in nature and of a higher TRL. To avoid any potential bias, randomly 5 EeB projects and 5 FoF projects from the sample were selected for this study.

3.4 Analysis plan

The first step is to create an overview of all collected data. For this Excel is used. All consortium characteristics are placed in a sheet, together with the influences identified from literature. When interesting new insights come forward from the cases these are also added to the file and checked in all 10 cases. In this step we make an easily navigable overview of the information.

In the second step we compare the information with the commercialization effort or plans of the projects. In this step we exclude characteristic that do not show an influence on commercialization of project results.

We elaborate on the characteristics remaining from the second step. Here we delve deeper into the cases and look for motivation or other information explaining the link to commercialization of project results. After this step we have a list of project characteristics that influenced commercialization in the 10 cases.

To validate the results from the 10 cases, they were compared to other similar cases that were performed for the purpose of evaluating FP7-NMP. These projects should have a TRL of at least 3 to exclude basic research, have a technological focus and include partners from the industry. The validation set consisted of 19 cases. All findings in section 4 are validated with this set which should strengthen the conclusion in section 5

4 Results

The analysis of the results found 4 characteristics which were found to be of influence on commercialization of project results: the scope of the project, collaboration within the project, the inclusion of value-chain partners, and technology maturity. In the next paragraphs the results of these characteristics are described in more detail.

4.1 Project scope

In the first scan, projects with a large budget and/or a large number of partners were *less* likely to commercially exploit the results of the project. While a large number of partners having a negative influence is in line with findings from literature, a large amount of funding negatively affecting commercial exploitation is not. Looking closer at the cases with a large number of partners and a large amount of funding, it turned out that these in general have a relatively broad scope. These projects try to integrate different technologies into a new concept. In the cases none of these concepts are (going to be) commercialized, however sometimes specific parts of the project are. The concept is not commercialized because this is impossible for a single organization. Most of all, this is due to some parts of the projects that are not developed enough to allow for commercialization. This makes the entire concept not viable for commercialization.

Projects of a smaller scope, with fewer partners, less budget and focused on developing a single technology are more likely to commercially exploit project results at the end of the FP7 project. This is because a single technology can be easily commercialized by a single company.

So when direct commercialization of project results is one of the intentions of the project, then smaller projects are more suited. This does not mean that large projects shouldn't be used. These large projects are more radical, focus on up-scaling of technology or focus on applying technology in a new area. Three of the four large projects reached their scientific and technological objectives. They are purposeful from a scientific or technological perspective, and in the longer term the large projects may have commercial influence on project participants, but this could not be found in the results of the case studies.

4.2 Collaboration and project management

In projects with more partners, it becomes more difficult to collaborate, which was already indicated in the literature review. A large number of participants in a project makes it very hard to make decisions. Participants in larger projects are also more likely to focus on the work within their own work package. This sometimes leads to insufficient collaboration between work packages, making integration efforts harder. When projects are split into smaller sub-projects, collaboration is easier when integration efforts receive enough attention.

When something unexpected occurs in a project, changes in the project need to be adopted. This is hard with a large number of partners, or when a project coordinator doesn't want to do so. It is also the coordinators' role that underperforming partners are pulling their weight. Good management of the project is therefore crucial, especially in larger projects. While project management and collaboration do not have a direct effect on commercialization, they do have a direct effect

on project success, which is a requirement for commercialization in the first place.

4.3 Value-chain partners and end-users

In all of the cases the partners in the project covered the value chain. In six of the cases this was explicitly mentioned as an enabler of the project. There were cases which involved the end-user of the technology being developed. Interviewees mentioned this as very helpful. The project participants get direct feedback from their potential customer, making it better suited for their needs, while on the other hand it creates interest for the technology. Generally when project results are being commercialized in the smaller projects, the value chain partners will commercialize their part. Of the six smaller projects, five plan to commercialize. Of these five, four commercialize in parts and one uses an academic spin-off. For the project to work developments across the value chain are needed. It is interesting to see that these projects not only commercialize the final technology but also parts of technology that were developed in other parts of the value chain.

To conclude on value chain partners and end-user, when the results of the project are intended to be commercialized, the participants should cover the value chain and invite the end-user. This will increase the likelihood for a commercially viable technology at the end of the project.

4.4 Technology Maturity

The last factor influencing commercialization is technology maturity at the start of the project. When technology is still at the early stages of development, around TRL 3-4, it is very unlikely that at towards the project finalization the technology is ready to be commercialized. Evidence was found in the cases that technology was not ready for commercialization because it was either underperforming or too expensive. When projects started at a higher TRL, it was more likely that the technology was commercialized. When at the end of the project the intention is to commercialize results, the technology should be of at least TRL 5 (out of 9), on the TRL scale this means that the technology has already been proven in a lab and relevant environment.

5 Conclusion

This study started with the question: what characteristics of research and innovation projects stimulate or hinder commercialization of project results? From our analysis 4 characteristics were identified that either stimulate or hinder commercialization. First when project participants intend to commercialize project results after the project, then the project should be smaller of scope. The results of this study strongly indicate that a project which is small of scope is more likely to commercialize results. Second, in smaller projects, collaboration between partners has less difficulties and project management is easier. Third, the partners that are involved should cover the value chain in order to have the necessary development in the chain to produce the new technology. If possible the end-user should be involved to get fast feedback in the project and keep the technology close to the user needs. And lastly, the technology should be mature enough at the start of the project. Else the technological risks are too high, which means that the technology can underperform or is too expensive for commercial exploitation.

When a project is large of scope, in which different technologies are integrated into a new technological concept, commercialization is less likely. First of all, the concept cannot be commercialized by a single organization, but needs collaboration for commercialization. Most of the time not all technologies in this project are developed fully enough to allow for commercialization, which makes the entire concept not viable for commercialization. Larger projects also have more difficulties with collaboration: decisions in the project are hard to make because of the large number of partners involved. This does not mean that large projects should be stopped. The large projects are achieving their objectives as often as the smaller projects in the 10 case-studies. They are significant for creating technological and scientific advances.

5.1 Research limitations

Our research has some limitations that should be acknowledged. The first and most important one is that the cases focus on a new type of project, the public-private partnerships. These projects were introduced in 2009 under the rules of FP7. Because of this novelty, the projects were not yet finished or had only just finished. Therefore a lot of the results are based on progress in the projects and concrete plans to commercialize. Subsequently, follow-up research is needed to verify the results of this project.

The data used was collected for the evaluation of the Nanosciences Nanotechnology, Materials and new Productions theme of the 7th framework programme (FP7-NMP in short). This evaluation did not focus solely on commercialization of project results. In the 10 cases used for this research more attention is given to commercialization, for the cases used in the

validation set this extra attention was not given. However without this evaluation, access to confidential sources and contacts for interviews would be much harder.

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

The last limitation is not really a limitation of the research but a limitation in reporting on it. It concerns the confidentiality in this project. The interviews and documentation from the European Commission are confidential, and can therefore only be shared on an aggregated level.

5.2 Suggestions for further research

In our research we found some interesting leads for further research. This exploratory research was limited to projects funded by FP7-NMP. To start with, it is not yet known if the results are generalizable to other EU supported research and innovation programs. Future research should explore the characteristics in other programs. This exploratory research identified characteristics that can be used in more case study analyses

Halfway through the evaluation, the European Commission asked to study the effect of Exploitation Strategy and Innovation Consultant (ESIC) services. These services help participants with their exploitation strategy and to overcome non-technological risks such as IPR issues, regulatory issues and financial issues. No influence of ESIC services was found in the cases, but interviewees mentioned that the services helped them with their exploitation plan. Further research could focus on these services and their effect on the commercialization of project results as they seemed helpful.

In this study we found projects that focused on SME participation. While these projects had a large number of partners, this was not perceived as a problem. Furthermore these projects were likely to commercialize results. In this research we did not focus on SME participation, but it potentially seems to have a positive effect on commercialization of project results. This is an interesting topic for further research.

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