TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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PROJECT SUCCESS OF SMALL AND MEDIUM-SIZED FIRMS IN EUROPEAN PUBLICLY FUNDED RESEARCH AND DEVELOPMENT

Master of Science Thesis

Examiner: Professor Miia Martinsuo
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ABSTRACT

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This study is concerned with the business development of small and medium-sized enterprises (SMEs) through their participation in the international R&D collaboration projects funded by European Commission and related sources. SMEs receive increasingly more attention from policymakers as they create the most employment. European Union is targeting extensive innovation support for SMEs and many individual countries also have their own SME support policies. This study examines the business development and the factors explaining the success for SMEs which have participated in these publicly funded projects.

Based on literature, the study creates a model on the success of SMEs' publicly funded projects and identifies 13 hypotheses on its antecedents. Project success is measured in terms of innovation success criteria identified based on the literature review. The associations between variables are hypothesized based on literature and further tested by statistical analyses. The target group of the study is more than 10 000 European SMEs which have participated in the Seventh Framework programme (2007 to 2013) and Eureka programmes including Eurostars (2004 to 2014) with the main focus in 11 European countries. The final sample consists of 711 SMEs.

The main business outcomes SMEs can attain in the projects are shorter time for innovations, new or improved products, new recruitment, higher sales from market novelties, improved R&D, improved human capital, and encouraging more fundamental R&D. The study was capable to provide some implications for research and practice. The findings show that knowledge transfer has the strongest impact on project success and it should therefore be promoted by the project participants. Money and capability to apply external knowledge were important but have no association with project success. The study also found out that previous experience in similar projects, often favored by funding agencies, is mainly important to be successful in networking. The findings also show that experienced limitations of knowledge can lead to more experienced benefits with networking and knowledge transfer in the projects. The findings regarding to negative sides of the projects suggest that SMEs should avoid participating in irrelevant projects and projects with too extensive project scale with respect to their resources. The study also indicates that problems with administration constrain the chances to attain benefit with knowledge transfer, networking and enhanced brand in the projects.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Tuotantotalouden koulutusohjelma
TALA, MIKA SAMUEL: Pienten ja keskisuurten yritysten projektin onnistuminen eurooppalaisissa julkisrahoitteisissa tutkimus- ja kehitysprojekteissa
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Tutkielman tarkastelee pk-yritysten liiketoiminnan kehittymistä Euroopan komission ja vastaavien tahojen rahoittamien kansainvälisten t&k-projektien kautta. Pk-yritykset kiinnostavat päättäjiä yhä enemmän, koska niillä on merkittävä rooli työllistämisessä. Euroopan unioni kohdentaa laajamittaista tukea pk-yritysten innovatiivisuuden edistämiseksi ja useat maat ovat luoneet omat pk-yritysten tukimekanisminsa. Tämä tutkielma tarkastelee näihin t&k-projekteihin osallistuneiden pk-yritysten liiketoiminnan kehittymistä ja projektien menestykseen vaikuttavia tekijöitä.

Kirjallisuuteen perustuen, tutkielma luo mallin julkisrahoitteisten t&k-projektien onnistumisesta ja tunnistaa 13 hypoteesia onnistumista selittävistä tekijöistä. Projektien onnistumisen määrittävät tekijät tunnistetaan kirjallisuuskatsauksessa. Muuttujien välisten suhteiden lähtökohtana ovat päätelmät aikaisemman tutkimuksen tuloksista, ja niitä testataan tilastollisesti. Tutkielman kohderyhmänä on yli 10 000 eurooppalaista pk-yritystä, jotka ovat osallistuneet Seitsemänteen puiteohjelmaan (2007 - 2013) ja Eureka ohjelmiin mukaan lukien Eurostars (2004 - 2014). Tutkielman pääfokus on 11 Euroopan maassa ja lopullinen otos sisältää 711 pk-yritystä.

Pk-yritysten liiketoiminnan kehityksen onnistumista projekteissa ovat lyhyempi innovaation läpimenoaika, uudet tai parannellut tuotteet, uusi työllistäminen, korkeampi myynti markkinauutuuksista, t&k-toiminnan kehittyminen, kehittynyt inhimillinen pääoma ja perustavanlaatuisempi t&k-toiminta. Tutkielma onnistui löytämään uutta tietoa teorialle ja käytännölle. Tulosten mukaan tiedon välityksellä on suurin yhteys projektien onnistumiseen, joten projektin osallistujien tulisi pyrkiä edistämään sen toteutumista käytännössä. Raha ja kyky hyödyntää yrityksen ulkopuolista tietoa ovat tärkeitä, mutta ne eivät ole yhteydessä projektin onnistumiseen. Tutkimustulosten mukaan rahoittajien suosimasta aikaisemmasta kokemuksesta on hyötyä pääosin verkostoitumisessa onnistumisen kannalta. Tulosten mukaan enemmän tietämykseen liittyviä rajoitteita kokevat pk-yritykset kokevat enemmän tiedon välittymiseen ja verkostoitumiseen liittyviä hyötyjä. Projekteiden ongelmiin liittyvien löydösten mukaan pk-yritysten tulisi välttää osallistumista irrelevantteihin projekteihin ja laajuudeltaan suhteessa omiin resursseihinsa liian suuriin projekteihin. Tutkimus näyttää myös, että ongelmat projektien hallinnoinnin kanssa voivat rajoittaa tiedon välittymiseen, verkostoitumiseen ja brandiin liittyviä hyötyjä projektien aikana.

PREFACE

I am carrying out this research for my Master of Science thesis in Tampere University of Technology (TUT). My objectives are to point out the benefits for SMEs from EC and related project funding in more than ten European countries, graduate with an interesting master's thesis topic and further develop my knowledge in international R&D collaboration. I am not affiliated to the European Commission or any of the associated funding agencies. The research work is carried out within the collaboration between TUT, Helsinki Institute of Physics at CERN, and Bgator Ltd.

This research took physically place at CERN during a period of six months from 10th March, 2014 until the end of August, 2014. The analyzing part and writing the thesis was continued in Finland and the final version of the thesis was finished and submitted in December 2014. Writing the thesis has been an excellent learning experience and included a lot of work. For instance, collecting the contact details of the target group 10 000 SMEs required me more than two months full-time work. Luckily my younger brother could do a three week internship at CERN to collect the contact details; otherwise it had required even more time.

I would like to thank my examiner professor Miia Martinsuo for a lot of help and support throughout the process. Professor Martinsuo helped me especially with the statistical analyses. I should also mention my supervisor Antti Heikkilä who helped me at CERN to gain more understanding in R&D collaboration and to experience working with preparation of real life R&D projects funded by European Commission. It is also worth to mention Pietari Kauttu who provided me much knowledge regarding to public funded projects at CERN. Finally, I would also like to thank my brother Niko Tala who did a three week internship at CERN to collect contact details of the SMEs.

Tampere, 18th December 2014

Mika Samuel Tala

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TERMS AND DEFINITIONS

SME	Small and medium-sized enterprise, a company with less than 250 employees, less than €50 million turnover and a maximum investment of 25% from one or more other companies.
R&D	Research and development which takes place in companies and generally carries more uncertain return on investment and greater risk than other organizational activities.
R&D collaboration	Inter-organizational research and development including partners such as small and medium-sized companies, large companies, research organizations and universities.
FP7	Seventh Framework Programme (2007 to 2013) is a public funding programme created by European Union and European Commission to support and foster research.
Eureka	Intergovernmental pan-European research and development funding and coordination. Provides an Eureka label which may entity research funding from national funding agencies for international R&D collaboration.
Eurostars	A joint public funding programme between Eureka and the European Commission launched in 2007. The first funding and support programme specifically dedicated to research-performing SMEs.

1. INTRODUCTION

This chapter provides the background and the guidelines for the thesis. The background showing the current trends concerning distributed innovation networks is first provided in subchapter 1.1. Goals, scope and research design are then provided in subchapter 1.2. After these, subchapter 1.3 shows the structure of the thesis.

1.1 Background

Innovative companies are increasingly dependent on networks and external knowledge. Herstad et al. (2014) mention there is a shift from global production networks driven by search for markets and low cost production towards global innovation networks based on search for knowledge. The trend is towards distributed innovation networks where innovation is shifting away from individual companies. Kaufmann and Todtling (2000) report similar effect of emerging regional innovation systems, as a consequence of the fact that innovations need creative ideas and advanced knowledge that usually originates from research organizations and universities.

European Union provides funding for collaboration of research. This funding aims to influence collaboration which is believed to enhance research productivity among the participants. (Defazio et al. 2009.) Previous programmes have included: (i) direct R&D project funding, writing proposals for projects and possibly activities concerning dissemination of research results, (ii) promotion collaboration between actors, and (iii) involvement of both public and private organizations in the research. (Bach et al. 2014.) Projects usually include participants from several countries (Haour 2004, 76).

Small and medium-sized enterprises (SMEs) receive increasingly more attention from policymakers as they create the most employment. European Union is targeting extensive innovation support for SMEs and many individual countries also have their own SME support policies. (Hoffman et al. 1998.) SMEs constitute 98% of European firms and provide two-thirds of employment in European Community (Romero-Martinez et al. 2010). The European Union definition of SME is widely accepted today. SME is a company with less than 250 employees, less than €50 million turnover and a maximum investment of 25% from one or more other companies. (Gilmore et al. 2013.)

In Finland, the national technology support has been more important than EU support both in terms of money and in terms of usefulness (Luukkonen 2000). Romero-Martínez

et al. (2010) point out that not many companies in Spain use EU funding. According to them this is partly because in countries such as Spain most of the funding comes from local and regional authorities. Gilmore et al. (2013) also recognize the concern regarding to low participation of SMEs in European R&D funding mechanisms. Therefore it is a good question whether SMEs have no interest or they do not know how to benefit from public R&D funding provided in European level.

1.2 Goals, scope and research design

The purpose of this study is to explain the factors affecting project success for small and medium-sized enterprises (SMEs) in international R&D collaboration projects funded by European Commission and related sources. The study expects to find out that SMEs can benefit participating in the projects. The most important benefits could be related internationalization, enhanced R&D and new opportunities for innovation.

This study is particularly concerned with SME business development through participation in these international R&D collaboration projects. Two most important issues here are: 1) what kind of business development can SMEs attain through EU and related funding, and 2) what are the factors explaining the success in these publicly funded projects. The study has an organization level focus in microeconomic perspective of SME business development.

There are several previous studies which have investigated EU funded projects and the impact of public subsidies in other parts of the world. Previous research has for example concentrated on project outputs and motivations (Mialhe et al. 2012), R&D collaboration (Kang and Park 2012; Negassi 2004), and barriers for participation to the projects (Gilmore et al. 2013). This master thesis combines different research findings concerning the project outcomes, characteristics of SMEs, experienced barriers during the projects, and experienced benefits. Previous research has not tested benefits and barriers in the same model, lacking the whole picture of experiences in the projects.

The scientific method of the thesis is hypothetico-deductive model. In the method, scientific inquiry proceeds by formulating hypotheses that can be tested with observable data. The hypotheses are formulated based on previous literature and the data for the tests is collected through questionnaire. The approach tests general hypotheses by deducing predictions. When the prediction is falsified the theory is rejected and requires a new hypothesis. Observations agreeing with predictions confirm the hypothesis.

Based on literature, the study creates a model on the success of SMEs' publicly funded projects and identifies 13 hypotheses on its antecedents. Project success is measured in terms of innovation success criteria which are identified in the literature review part. The expected associations between variables are based on literature and further tested

by statistical analyses. The data collecting method was an electronic questionnaire. The responses were analyzed by using statistical methods. The questionnaire was first mailed on July, 2014 and responses were collected gradually until August 2014.

The target group of the study is more than 10 000 SMEs which have participated in the Seventh Framework programme (2007 to 2013) and Eureka programmes including Eurostars (2004 to 2014) in more than ten countries around Europe. The whole time frame of the Seventh Framework programme was included. Eureka projects which had finished before the year 2004 were excluded to increase reliability by concentrating on the projects finished during the last 10 years. The final sample consists of 711 SMEs.

Only the responses of SMEs were analyzed, excluding other organizations such as big companies and universities. The study concentrates on R&D collaboration programmes in European level, leaving the national funding programmes and self-funded projects out from the scope. All the investigated programmes include collaboration of participants from at least two countries. Theory has mainly an organization focus in publicly funded R&D projects and SME business development, excluding for example the theory surrounding national and international innovation systems and networks.

1.3 Thesis structure

Literature review is divided into two chapters. Theoretical background (Chapter 2) provides the economic science background of public subventions, describes the characteristics of SMEs, and creates a basis for measuring project success in the publicly funded projects. Antecedents of projects success (Chapter 3) first presents an overview of the model, then structures the hypotheses of the barriers and the benefits experienced during the projects, following the hypotheses for SME control and background variables. The complete literature model and list of the hypotheses are provided in the end of chapter 3.

Research method and data (Chapter 4) describes the process of preparing the questionnaire, collecting the survey responses, and operationalization of the variable structures, resulting to the final model and updated hypotheses. This chapter also shows the background information on the respondents before the exploratory factor analyses. Exploratory factor analyses are carried out to identify the variable structures for the hypothesis testing. Data analysis subchapter discusses the required assumptions for linear regression analyses which are conducted to test the associations between independent and dependent variables.

Results (Chapter 5) begin with descriptive statistics and correlation coefficients to assess the properties of the data. After descriptive statistics, Antecedents of project success subchapter shows the results of the linear regression analyses: the variables

associated with project success. After the results for project success, further regression analyses for project benefit variables were conducted to investigate their mediating role between project success and several other variables. Summary of the hypothesis testing is provided in the end of the chapter.

Discussion (Chapter 6) first shows the summarized results of the hypothesis testing. After that discussion is divided into four subchapters linking the findings of the study with previous literature. The discussed points of views are money and resource issues, knowledge transfer and networking benefits, the direct and mediated associations of barriers, and the role of SME background concerning networking benefits.

Conclusions (Chapter 7) chapter specifies and summarizes the findings of the study. The first subchapter shows the summary of the study, following the implications of the study: SME business development in publicly funded R&D collaboration projects. Limitations of the study and ideas for future research are presented in the end of the chapter.

2. THEORETICAL BACKGROUND

This chapter provides the most relevant theoretical background for public subventions, the characteristics of SMEs and metrics of measuring project success in publicly funded R&D projects. Economic science background of public subventions will be presented in subchapter 2.1 with the basic logic why public subventions are provided for R&D projects and why the public policy promotes inter-organizational collaboration. The characteristics of SMEs in terms of their size and R&D are reviewed in subchapter 2.2. After SME characteristics the subchapter 2.3 develops the basis for measuring project success of publicly funded R&D projects.

2.1 Economic science background of public subventions

The aim of governmental intervention in funding research is to encourage and support research activities which may otherwise not be carried out. Some R&D activities are difficult to finance in free and competitive markets. Typically these research activities include appropriability problems and problems with uncertainty, spill-overs of knowledge since the use of knowledge by one firm does not restrain the use of it by others and information asymmetry which are most prominent variants of market failure hampering innovation activities. (Hall 2002.) According to Steinmuller (2010) innovating may benefit (1) consumers or clients, who have access to improved products without necessary being charged an increased price, and (2) competitors and the rest of the economy may use the technology created by the innovator without paying anything.

Because of market failures, the investment in innovation is inferior to its socially optimal level and less than socially desired (Arrow 1962; Nelson 1959). To cope with these market failures, public programs often directly contribute to firm's R&D investments by the means of a subsidy, and hence the risks and costs of innovation are shared and reduced (Hall & Lerner 2010). Although, public funding should not directly substitute for corporate investment in R&D, instead it should be additional to what is done anyway (Buisseret et al. 1995). Luukkonen (2000) stresses that some attention is previously drawn to public funding's role to substituting corporate investment in R&D or leading to trivial R&D carried out for the sake of availability if public funding. According to Luukkonen participating in funding programmes may lead to trivial R&D which would not have been undertaken by the companies without the intervention of the public authorities.

The positive association with external government support and increased internal R&D is confirmed in previous research. Almus and Czarnitzki (2003) analysed the effect of public R&D policy for firms in Eastern Germany. Compared to a case with no public financial means, public funds increased innovation activities by about four percentage points. González and Pazó (2008) investigated public R&D support for Spanish manufacturing firms and their results show absence of crowding-out between public and private spending. Furthermore, mainly small firms operating in low technology sectors may not have been engaged in R&D activities without subsidies. Lach (2002) evaluated the effect of R&D subsidies in Israeli manufacturing firms and found evidence suggesting that the R&D subsidies greatly stimulate R&D expenditures for small firms. According to Hall (2002) there is limited evidence on additionality of the programmes since evaluating the programmes is difficult due to the lack of a control group constituted of similar firms not receiving funding.

Collaborating companies receive higher grants. The rationale of this policy is to increase incentives for inter-firm collaboration as collaboration is considered to trigger additional R&D spending and to enhance R&D productivity (Hottenrott & Lopes-Bento 2014). Connection between collaboration and R&D productivity is reported widely in former research. R&D collaboration, innovation intensity and incoming spill-overs from other participants were found to have impacts on productivity growth of Dutch innovating firms (Belderbos et al. 2004). Evidence from Japan shows enhanced R&D productivity through collaboration (Sakakibara 1997). Evidence from Bach et al. (1995) implies that projects with participants from complementary and different organizations (i.e. universities with firms, producers with users) generated more positive indirect effects than partnering with similar organizations. Schwartz et al. (2012) had similar results concerning R&D collaboration between private firms and universities. They also suggest that large-firm involvement in R&D collaboration has positive impact on innovation output. Radas and Božić (2009) found out that having links with academic institutions has a strong positive effect on radical product innovation.

Some research has suggested that international partnerships are more effective and have stronger effect on innovation performance than domestic ones (Kang & Park 2012). EU framework programmes have a condition that research takes place in consortia with partners from different member states of European Union. EU collaboration leads to consortia with different interactions which would unlikely be carried out in the same setup. (Luukkonen 2000.) Research also suggests that subsidies significantly reduce the subsidized companies' likelihood to merge and support the independence of firms which otherwise would have merged. These findings imply that subsidies also improve companies' future prospects. (Ebersberger 2011.)

2.2 Characteristics of SMEs

SMEs are considered more often financially constrained in comparison with large companies. Hausman (2005) suggests that SMEs have limited resources and capabilities for conducting in-house R&D activities. Narula (2004) also reports that small firms are constrained by limited resources. Resources required to expand R&D activities include capital investment and managerial resources, which according to Narula, these firms simply do not have. The findings of Thorpe et al. (2005) on using knowledge within SMEs generally show that SMEs have limited resources compared to large companies. The results of Chang and Chen (2004) research of Taiwanese SMEs which participated in publicly funded projects show that SMEs are limited in size and lack sufficient R&D personnel. They point out that larger firms control greater amount of funds and hence have higher ability to bring in talented people, purchase equipment, establish R&D systems and transfer technology in contrast to SMEs.

Previous research shows that SMEs may face higher limitations on conducting R&D compared to large companies. Radas and Božić (2009) present that SMEs are expected to have higher barriers to innovation compared to large firms because they have inadequate expertise and resources. Narula (2004) compared empirically SMEs and large firms on the electronics hardware sector within the ICT sector where SMEs are in direct competition with large firms. Narula's findings show that large firms spent five times more on R&D than SMEs and large firms were on average three times larger in terms of R&D employees. Narula's example shows that when a firm is bigger it can easily maintain larger R&D department even though the R&D intensity of a small firm would be twice more than the R&D intensity of the large firm. Gilmore et al. (2013) points out that many SMEs are unable to undertake product development on their own within competitive scale due to a weak internal R&D capacity.

Hall (2002) proposes that problems related to financing investment in new technology are most apparent for startups and new entrants and this is why many governments provide assistance for such firms. According to Romero-Martínez et al. (2010) funding is one of the main problems faced by SMEs. They conclude that this is one of the base reasons for EU targeted funding to SMEs. Regarding to introduction of new technology, Romero-Martinez et al. (2010) add that the size of SMEs places restriction on access, implementation, and use of the new technologies. In addition, they suggest that entrepreneurs may have limited understanding of financing options and they often do not accept to lose the control over their company. Hoffman et al. (1998) show that the lack of availability of funding for innovation has long been considered a serious constraint on SME growth in the UK.

Small companies rely more on technological developments outside the company than large companies. For example small firms have more tendency to be dependent on

patents outside the firm and produce less patents inside the firm than large firms. (Hicks & Hedge 2005.) Baum et al. (2000) investigated biotechnology startups and they predicted that startups could enhance their performance by 1) participating alliances, 2) networking efficiently to access diverse capabilities and information with minimized costs of redundancy, complexity and conflict, and 3) allying with rivals for more opportunities to learn and to reduce risks of rivalry between alliances. The importance of external R&D collaboration for SMEs is proved by for example Sakakibara (1997) whose results show that in Japanese consortia smaller companies perceived more benefits than large firms.

SMEs have relatively little to offer when partnering with large companies and partnering may create a strategic threat to SMEs. Big companies have more to offer and their technological portfolio is larger. For the industries where the technological change is rapid SMEs need to learn from their markets and competitors wherever they are. (Narula 2004.) SMEs may feel the urge to cooperate with others to acquire competencies and knowledge but they often lack the knowledge base to absorb the required knowledge or face difficulty with finding partners (Kirkels & Duysters 2010). When SMEs enter international markets they encounter stronger competitors and have to innovate to gain their position (Radas & Božić 2009).

The lack of SMEs' experience in networking is reported by some former research. Mancinelli and Mazzanti (2009) conducted surveys on industrial and market-service SMEs with at least 20 employees in North-Eastern Italy. Their random sample of 250 firms report both the lack of R&D and very little development in networking of SMEs. Nunes et al. (2010) investigated Portuguese service SMEs and point out that SMEs with non-high levels of R&D intensity generally lack experience in managing R&D projects. In contrast, high-tech service SMEs with higher levels of R&D intensity seemed more efficient in managing external finance and more dependent on internal finance.

Rosenbusch et al. (2011) report that in comparison with large companies, SMEs may lack experience needed for the management of external collaborations and R&D projects. Hottenrott and Lopes-Bento (2014) mention that when attributing a subsidy to a firm governments are interested in 1) firm's previous experience with R&D projects and also 2) firm's previous experience with a specific funding scheme. Governments may favor firms previously conducting successful R&D (measured for example by patents). (Hottenrott & Lopes-Bento 2014.) Kim and Vonortas (2014) also highlight the importance of previous experience and especially the experience of the leadership with collaboration in the project.

Small size is seen a benefit for SMEs in some previous research. Some features of small businesses suggest increased ability to respond to changing needs of the environment (Hausman 2005). Advantages of SMEs include flexibility and better ability to use

external networks (Davenport & Bibby 1999). SMEs also have a capability to start up innovative enterprises and have higher ability to identify opportunities that larger businesses have missed or are not interested in. in (Gilmore 2011).

In conclusion it is worth to fund SMEs because they have limited resources and have more problems related to availability of funding for innovation. SMEs are also more dependent to knowledge outside of the company than large firms and they may face more difficulty in finding partners because they have relatively less to offer for exchange. Evidence also shows that SMEs may lack experience in R&D projects or collaboration in innovation. Benefits of SMEs are flexibility to change and ability to identify opportunities and respond to changing needs.

2.3 Measuring the success of publicly funded projects

The positive association with public funding of the research and increased internal R&D has been confirmed in previous research (Almus & Czarnitzki 2003; González & Pazó 2008; Lach 2002). The aim of this subchapter is to define the determinants of project success for SMEs based on literature and previous research on measuring R&D collaboration success and success of publicly funded R&D projects. Summary of the success measures is presented in Table 1 in the end of the subchapter.

According to Flor and Oltra (2004) innovation can be measured in terms of inputs or outputs of the innovation process. Inputs include R&D budget, existence of formalized R&D department in the company, participation in R&D projects with other organizations, acceptance on publicly funded innovation support programs, and educational background of the staff. Outputs include for example number of patents, identification of innovations by company managers, and share of sales from innovative products. (Flor and Oltra 2004.) Brouwer and Kleinknecht (1996) suggest using indicators of the innovation process output side. They claim that once innovation output is directly measured one can study factors influencing the relationship of innovation input and output. The following paragraphs present the outputs which are used as success measures in this master's thesis.

One benefit of the projects is found to be reduction of innovation time-span and improved innovation performance. Narula (2004) mentions that the primary motives for both small and large firms in inter-firm R&D collaboration were the reduction of innovation time span and access to complementary technologies. Romero-Martinez et al. (2010) demonstrated empirically the importance of EU funding for improved innovation implementation in Spanish SMEs through several logistic regression models. Their results show that SMEs receiving EU funding are more likely to implement innovation in technology (products and processes) or organization (management systems, organization of work), or develop relations with other institutions. Kang and

Park (2012) investigated 147 biotechnology SMEs in South Korea from 2005 through 2007 and found out that the government support through project funding affects SMEs' innovation directly and indirectly by stimulating internal R&D and domestic collaboration.

Some of the former research has not found evidence between subsidies and increased innovation performance. Radas and Božić (2009) investigated Croatian SMEs through a postal survey of 448 SMEs in 2004. Their data did not show evidence that having received government or municipality subsidy increases SME innovation probability.

New or improved products have been widely used as a measure for innovation success in former research. Massa and Testa (2008) interviewed entrepreneurs regarding to the definition of innovation and concluded that innovation should be something that is strictly connected with the market. As mentioned above, Romero-Martinez et al. (2010) found out the connection between SMEs receiving EU funding and innovation in technology and more specifically in products and processes. New or improved products are therefore considered one of the most important aspects of success in innovation.

The findings of Chang and Chen (2004) show that government subsidies positively affected the probability of SMEs' market introduction and sales of new products in Taiwan. Their results indicated that self-provided funds for R&D, firm size, number of R&D personnel and higher ratio of master's degrees holders were important for the outcomes. Although, some authors see the lack of support for new products a problem for R&D collaboration. Gilmore et al. (2013) identified barriers related to SME participation in national and international R&D programmes within the European Union. They state that most support resources are dedicated to co-funding of the product or technology development lacking support for the commercialisation of new products. Gilmore et al. mention that commercialisation of new products is often the most serious problem for innovating firms.

Mialhe et al. (2012) identified possible motivations and different outputs of the EU programme for collaborative research in the health field. Their analysis included 2245 questionnaires from October to November 2011. According to them the SME targeted topics have had success in increasing SME participation in health research programmes. In these programmes SMEs benefited most by networking and/or coordination of science. The second most important benefit for SMEs was new or improved products which underlines the positive impact on industrial product development in the Health research programme.

The project success can also be measured by creation of new jobs. According to Mialhe et al. (2012) the health programme had also a great impact on the creation of new jobs and new SMEs. The questionnaire replies show that the research projects of the Health

programme have led to the creation of about 11 000 jobs consisting of PhD, post-doctoral fellows and technicians or support staff. One or more SMEs were created in the work of the project of 7.4% of respondents and of which 94% continued to operate after the project.

New products have been used as a success criterion of R&D collaboration. Negassi (2004) investigated R&D cooperation in France by measuring project success through the sales of innovative products. Results show that the success of innovations of French companies depended mainly on size, R&D intensity, market share and human capital. They also highlight the role of ability of a firm to integrate external knowledge through absorptive capacity. Also Flor and Oltra (2004) suggest new products as a meter for measuring technological innovation.

Hottenrott and Lopes-Bento (2014) analysed the targeted innovation policy in Flanders, the northern part of Belgium. The research concentrated on if the innovation policy fosters innovation performance in the recipient firms and whether the publicly induced part of the R&D investment translates into product market innovations. Their results show indeed higher input additionality for SMEs and especially for internationally collaborating SMEs. They also found out that SMEs benefit more than large companies. According to them the subsidies lead to product market innovations. International collaborators and SMEs had the highest effect of policy-induced R&D investment on sales from market novelties. Their results thus show that R&D induced by public subsidies does indeed contribute to innovation performance of SMEs.

Former research identifies patents as one criterion to measure project success. Kang and Park (2012) found out that government R&D support had a strong direct and positive effect on firm patenting outcomes. Mialhe et al. (2012) health field findings show that 23.8% of respondents indicated that they are listed as inventor on one or more patents arising from the projects. Of the patent applications, 45.5% were granted and 51% were licenced. According to Massa and Testa (2008) patents are not the most reliable way to measure project success. They mention that entrepreneurs do not appear to rely on the effectiveness of patents to appropriate their investments in innovation. Their interviews show that in some cases secrecy may be more effective than patents.

Schwartz et al. (2012) used patent applications and publications emerged directly from the project as measures of R&D project innovation performance. They used patent applications instead of patents granted to avoid underestimation of innovation output while there may be a long time span to granting a patent. Their results show that large firm participation is generally positively associated with patents while university participation was associated with increased publications.

Three more indicators considered are improved R&D, improved human capital and encouraged more fundamental R&D. Kang and Park (2012) found positive indirect

effects of government R&D support mediated by internal R&D resources and inter-firm collaborations. Government R&D support had a strong positive effect on R&D intensity and human capital. Hottenrott and Lopes-Bento (2014) mention that public co-financing of R&D projects has a significant effect on firms' innovativeness. Public funding also encourages R&D of more fundamental nature. The conclusion of the criteria for measuring the success of publicly funded projects is presented in the following Table 1.

Table 1. *Project success criteria for SMEs*

Shorter time for innovations	Narula 2004
New or improved products	Hottenrott & Lopes-Bento 2014 Gilmore et al. 2013 Mialhe et al. 2012 Romero-Martinez et al. 2010 Chang & Chen 2004
New recruitment	Mialhe et al. 2012
Higher sales from market novelties	Hottenrott & Lopes-Bento 2014 Flor & Oltra 2004 Negassi 2004
Patent applications	Kang & Park 2012 Mialhe et al. 2012 Schwartz et al. 2012 Flor & Oltra 2004
Improved R&D	Hottenrott & Lopes-Bento 2014 Kang & Park 2012 Romero-Martinez et al. 2010 Radas & Božić 2009* González & Pazó 2008* Almus & Czarnitzki 2003* Lach 2002*
Improved human capital	Kang & Park 2012
Encouraged more fundamental R&D	Hottenrott & Lopes-Bento 2014

**Based on findings of increased internal R&D by public subventions (principle of additionality, refer to subchapter 2.1)*

Romijn and Albaladejo (2002) measured innovation by a huge amount of different measures and their conclusions claim that a combination of objective and subjective measures yielded more insights. They also stress that the present ways to measure innovation are relatively subjective and this makes the use of them partly problematic. Table 1 combines subjective measures (improved R&D, improved human capital, shorter time for innovations, more fundamental R&D) with relatively more objective measures (new or improved products, new recruitment, higher sales from new products, patent applications). Using several different subjective and objective measures is supposed to add validity of measuring the project success in this master's thesis.

One more issue is the relationship with perceived and objective measures of innovation. Kahn and Manopichetwattana (1989) found a significant positive relationship with scanning (data collected based on environmental factors) and perceived innovation. Jennings and Young (1990) compared objective and subjective measures of product innovation in corporate entrepreneurship. Objective data was collected by using archival data. For subjective measure they used a self-report questionnaire. They found no significant differences between two measures. However, there may also be a possibility to overestimate the perceived innovation outcomes when describing the results of the projects. By using different methods to gather data, Flor and Oltra (2004) revealed an over-assessment of activities regarding to positive considerations of product innovation.

Some of the excluded important outcomes mentioned by Mialhe et al. (2012) were for example publications in major journals (for 54% of respondents), and coordination of science beyond their own institution (52% of the respondents). Also Schwartz et al. (2012) used publications as a measure of R&D project innovation output. Although, these indicators are mainly important for measuring the interest of academic research institutions, and therefore are not considered important for SMEs in this master's thesis.

3. ANTECEDENTS OF PROJECT SUCCESS: HYPOTHESES

This chapter provides literature background for the hypotheses of this master's thesis. Overview of the model is first presented in subchapter 3.1. The hypotheses are related to barriers and benefits associated with project success (subchapters 3.2 and 3.3). After presenting the hypotheses for barriers and benefits this chapter provides insights for associations of SME size, R&D intensity, previous experience, limited resources, and absorptive capacity on project success in subchapter 3.4. The findings will be summarized into a model and list of the hypotheses in subchapter 3.5.

3.1 Overview of the model

The model was created based on previous research on publicly funded R&D collaboration projects. Experiences in the projects are divided into two different points of view: barriers and benefits. These can also be called limitations and opportunities (Narula 2004). There is previous research concentrating especially on SMEs in EU funded project context (e.g. Gilmore et al. 2013). However, the strength of this study is combining both barriers and benefits into the same model. This study strives to explain the whole picture including both negative and positive experiences of project participation and their association with project success. This type of quantitative model with both positive and negative experiences was not identified in previous research.

Some research has evaluated the negative side of participating in publicly funded projects. Gilmore et al. (2013) investigated barriers faced by SMEs in national and international R&D programmes. Bach et al. (2014) researched market failures, capabilities failures, and interaction failures in EU projects. In this study the word barrier was adopted for the category of the negative experiences in the projects and five barriers were identified in line with previous research: administration, irrelevance, financial barriers, network barriers, and intellectual property barriers.

Some research has focused on positive sides of participating in publicly funded projects. For instance, Mialhe et al. (2012) investigated motivations and expectations of participating in EU projects. Luukkonen (1998; 2000) evaluated EU support concentrating both on benefits and difficulties in project participation. Some of the research concentrated on international R&D collaboration of SMEs (e.g. Hottenrot & Lopes-Bento 2014) and some on government support and R&D collaboration (e.g. Kang

& Park 2012). The research on R&D collaboration generally seems to concentrate on benefits. The word benefit was adopted for the categories of positive experiences during the projects. Three benefit categories were identified based on previous research: reduced costs and risk sharing, networking experience, and new knowledge and resources. Overview of the model is presented in the following Figure 1.

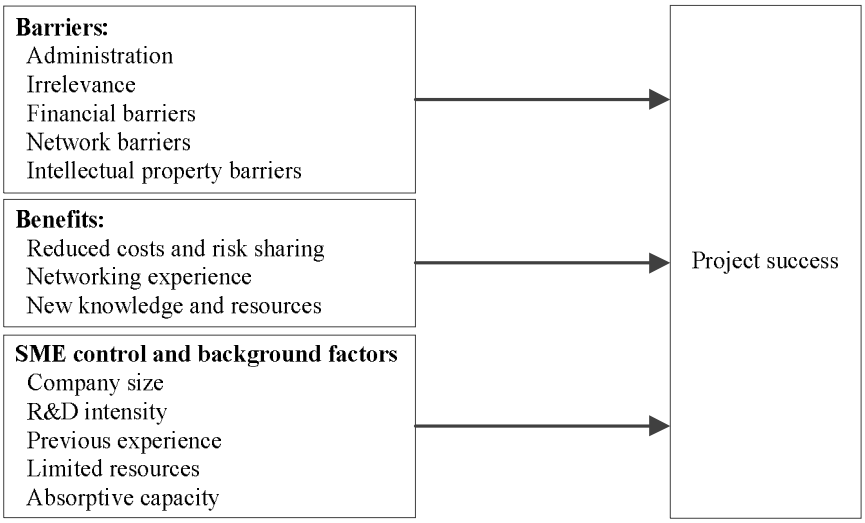

Figure 1. *Overview of the literature model*

Figure 1 shows the overview of the literature model. The main idea of the model is to explain the association between project success and the identified barriers, benefits, and SME control factors and background variables.

3.2 Barriers

This subchapter presents the five identified barriers. The barriers are administration, irrelevance, financial barriers, network barriers, and intellectual property barriers.

3.2.1 Administration

Previous research shows that administration of publicly funded projects can be a burden for SMEs which by definition lack resources. Administration barriers consist of complexity of the project administration, much time required for project administration, lack of expertise for administration required, complexity and length of the process, and demanding funding agency rules and requirements for project participants. Gilmore et al. (2013) identified barriers related to SME participation in national and international R&D programmes within the European Union. Their results are based on an online questionnaire of 764 companies across 27 EU countries and Bosnia and Herzegovina. 672 companies out of 764 had participated in a national or regional R&D programme between 2005–2010. Gilmore et al. define administrative barriers as lack of time and expertise in administration required to participate in R&D programmes. They also mention that a lot of paperwork and policies require time and may be unfamiliar to

SMEs. According to their results the most frequently indicated barriers were related to administration and finance. 422 SMEs out of 764 perceived administrative barriers to their participation in R&D programmes. The complexity of the process was also perceived a significant barrier with 373 responses. Length of the process was perceived a barrier by 337 SMEs.

The access to programmes and preparation of proposals may be too difficult for SMEs with limited budgets, especially if they are newcomers. SMEs with these limitations may perceive too high administrative burden for accounting and project administration. (Gilmore et al. 2013.) Bach et al. (2014) mention that participation in a European framework programme project demands complying with certain rules (such as application procedures, involvement of European partners, etc). These rules may affect the motivations of firms to participate in these programmes. Massa and Testa (2008) found negative affect of strict and complex rules on innovation. All the interviewed entrepreneurs mentioned this. The entrepreneurs asked for a public system with less burden. The pressure was perceived to reduce the pace of innovation and cause the entrepreneur to lose time.

SMEs face limited expertise and inadequate resources (refer to subchapter 2.2). A previous study of SMEs in Northern Ireland and Australia found out that owners and managers of SMEs tend to be generalists and lack competences in networking (Gilmore et al. 2006). Gilmore et al. (2013) results also suggest that limited in-house knowledge regarding project management is a barrier among other administrative barriers. From these remarks we can conclude the following hypothesis.

H1. Administration barriers are negatively associated with project success

3.2.2 Irrelevance

Irrelevant projects usually have no benefit for the project participants. Irrelevance barriers include low strategic importance of the projects, project irrelevancy to company's objectives, and complex projects with long time-horizons. According to Narula (2004) niche and marginal competence are strategically less important and hence can be undertaken through alliances. The strategic importance of the technology determines the extent its development can be externalised. Luukkonen (2000) found out that EU money was more important for SMEs than big companies. However, SMEs were able to carry out the tasks within their strategic core through their own resources and they did this. Instead of being strategically important, the programmes provided SMEs additional resources and new possibilities for exchanges and informal contacts. These contacts would otherwise had been difficult to achieve. Although, Luukkonen emphasises that European programmes may also lead to trivial R&D which companies would not have been undertaken without the intervention of public authorities.

Bach et al. (2014) conducted research based on a research data of thousands of participants in FP5 and FP6 programmes. According to Bach et al. a difference between participation in an EU funded project and independent collaboration is that the partners receive subsidies and some of the information becomes public. The publicity of information has a direct influence on the strategic importance of the funded projects and the distance from the firm's core competences. When the activity is close to participating firms' core competences, they may keep the cooperation secret and self-funded. Their results comparing self-funded projects with EU funded projects further show that EU funded projects were similar to self-funded projects with respect to the costs and risks. The projects differed greatly in complexity, time horizon and distance from core capabilities. Self-funded projects seemed less complex, had shorter time horizons, and were closer to firms' core competences. (Bach et al. 2014.)

Bach et al. (2014) results showed that the research conducted was generally perceived as a long term oriented (in comparison with an average research project). Regardless of the instrument, the distance from core competences was generally perceived medium (similar to an average research project). Gilmore et al. (2013) suggests that irrelevance of programme aims to SMEs interest and no perceived need to participate in R&D programmes can be a barrier for participation in the projects. If the project is irrelevant, hence we can consider that there is no benefit (measured by the project success variables) for the company for participation in the project.

H2. Irrelevance barriers are negatively associated with project success

3.2.3 Financial barriers

By definition SMEs have limited resources and problems with availability of funding for innovation. Participation in the projects demands financial commitment. Financial barriers include long time-to-grant, low funding rates and too late returns from the projects. Massa and Testa (2008) mention that the entrepreneurs do not submit proposals to many EU calls. Both the academics and the entrepreneurs complain about the delay in receiving the grant and have extreme difficulty in making the investments required by the EU projects while receiving the money years later.

Financial barriers were also investigated by Gilmore et al. (2013). The barriers included low funding rates on offer, inability to get loans or provide bank guarantees and the unavailability of additional sources of finance. Their results show that the inability to get loans or provide back guarantees was listed 314 times. Low funding rates were mentioned 301 times. Furthermore they also state that the time-to-grant and time-to-pay times that are inherent in programme participation are considered too long and therefore remain an enormous barrier for SMEs which do not have the financial resources or capacity to launch the project without certainty of the research programme funding.

Luukkonen (1998) suggested that SMEs face too long time horizons and too late returns from the project. They cannot commit their funds for projects which have commercial returns after years and instead need commercial returns much earlier. Although, Luukkonen mentions there are exceptions such as small R&D intensive firms. When SMEs by definition have limited resources and the programmes may have long time-to-grant, low funding rates and late returns, it can be concluded that financial barriers are negatively associated with project success.

H3. Financial barriers are negatively associated with project success

3.2.4 Network barriers

Publicly funded research takes place in a consortium with potential for network barriers. Network barriers include lack of market orientation, limited guidance and knowledge of programmes, limited networks with potential partners, and ineffective collaboration through funding. As mentioned before in subchapter 2.3 Measuring the Success of Publicly Funded Projects, Gilmore et al. (2013) point out the problem that there is much less support for commercialisation of new products which is often the most serious problem for innovating firms. Most of the funding is currently dedicated for the product and technology development. Hence, the lack market orientation is a barrier which may constrain the benefits from the projects.

Luukkonen (2000) suggests that market orientation is difficult to combine with the other conditions of the framework programmes. The nature of framework programmes as 'open' networks and the handling of intellectual property rights causes new problems with the shift towards market orientation. According to Luukkonen the shift is not necessarily a positive factor for the companies. In addition, findings of Sakakibara (1997) imply that firms are not willing to cooperate in R&D when possibility for immediate commercialization is perceived.

Other external barriers to participation in R&D programmes include lack of marketing regarding the benefits of the project and poor communication about the project with policy makers and agencies (Stokes & Wilson 2006). Gilmore et al. (2013) results show that the most often perceived external barriers include limited marketing and information regarding to the programmes (cited 290 out of 672 SMEs), limited assistance and guidance from programme officers (247 out of 672) and inappropriate economic conditions.

Limited networks and ineffective collaboration in the projects can also be a barrier for SMEs. Gilmore et al. (2013) results suggest that limited networks and links with potential partners is a perceived barrier (listed 219 times). Defazio et al. (2009) investigated the pattern of collaboration and its effect on research productivity over time in EU-funding context. They employed a panel of 294 researchers in 39 EU research

networks during a 15-year period of time (in chemistry sector). They found out that during the period of funding the collaboration did not lead to an increase in research productivity and funding had more significant influence on research productivity. Although, in post-funding period the impact of collaboration on productivity was found out to be positive and significant (while level of collaboration decreases slightly within the network).

According to Defazio et al. (2009) there are more links in the research network in the funding period than before or after funding. They point out that it requires time to develop links which are effective in enhancing research productivity. They claim that on average collaborations through funding are not effective. According to Luukkonen (2000) some market failures in collaborative R&D programmes have related to the transfer and flows of information between firms or firms and public sector research. It can be therefore concluded that network barriers are negatively associated to project success.

H4. Network barriers are negatively associated with project success

3.2.5 Intellectual property barriers

Publicity of information and shared intellectual property rights (IPR) are some basic features of publicly funded research projects. Previous research shows that sharing of intellectual property rights might reduce the willingness to collaborate or be considered harmful for the project participants. As mentioned previously in subchapter 3.2.2 Irrelevance Barriers regarding to the strategic importance of the project, Bach et al. (2014) report that in EU projects participants receive subsidies and some of the information must be disclosed. The publicity of information has a direct influence on strategic importance of the projects and the distance from the firm's core competences. Luukkonen (1998) presents that Finnish firms have perceived a lot of problems in terms of intellectual property rights since the beginning Finland has been participating in these programmes. Luukkonen also suggests that this may had been due to the beginning of their learning curve regarding to the programmes. In EU consortia participants are required to share the results obtained.

Herstad et al. (2014) suggest that engaging in collaborative knowledge development may cause uncertainty concerning the control of the knowledge assets that are developed. The analysis was based on micro-data from the Norwegian Innovation Survey based on period 2002–2004 which contains observations from 2721 firms. Their observations contain 1404 innovation active firms of which 614 maintain innovation collaboration. Their findings show that the use of IPR protection increases the willingness of the firm to collaborate with globally dispersed partners. They suggest that the use of IPR protection measures is a significant determinant of innovation collaboration. Kim and Vonortas (2014) list several factors enhancing young and small

firms' probability to engage in alliances. One of the enhancing factors is operating in environments with perceived satisfactory intellectual property protection. In line with these remarks the following hypothesis can be proposed.

H5. IPR barriers are negatively associated with project success

3.3 Benefits

This subchapter presents the three identified benefits. The benefits are reduced costs and risk sharing, networking experience, and new knowledge and resources.

3.3.1 Reduced costs and risk sharing

As discussed in the characteristics of SMEs, they generally lack resources and may have problems with availability of funding (refer to subchapter 2.2). Therefore, sharing of development costs and risks may be an important benefit for SMEs. The economic theory background of public subventions is to cope with market failures by directly contributing to firm's R&D (refer to subchapter 2.1). It is emphasized that the risks and costs of innovation are then shared and reduced (Hall and Lerner 2010). Haour (2004, 74–75) describes the co-development as pooling of resources, technical competence, market intelligence and capital. This allows sharing of development costs and risks, moreover it is likely to enhance effectiveness.

Resulting from the Health industry survey on SMEs, Mialhe et al. (2012) find that the lack of funding at national level is considered one of the important factors (68% of respondents) for participating in EU health research projects. In the health field study, 80% of respondents indicated that none or little outputs would have been possible without EU funding. For 75% of respondents EU funding represented up to 50% of the research budget. Regardless of organization type, 60% of respondents indicated EU funding helped them to access other funding to expand or continue the project. Radis and Božić (2009) find out that in their sample financing and expenses are the factors that present the most problems for SMEs in Croatia. They emphasize the sources of financing are lacking in Croatia and most SMEs finance their innovation activities internally, with bank credits and supplier credits.

According to Narula (2004) the primary motivation of R&D collaboration for both big and small companies was not the reduction of risks and costs. As mentioned in subchapter 2.3, the reduction of innovation time span and the access to complementary technologies were more important. Bach et al. (2014) also state that cost and risk sharing related motives were not important. Also sharing similar resources was not considered an important motive in their sample of FP5 and FP6 projects. Access to complementary technologies and skills and being updated with new technological developments were more important. Bach et al. suggest that policy makers should

consider complementarity of knowledge as more critical factor than cost-sharing. This would mean more precise consortia with firms from diverse industries, cooperation with universities and so on, which has more positive influence on outcomes.

Defazio et al. (2009) investigated collaboration and its effect on research productivity over time in EU-funding context. As mentioned earlier in subchapter 3.2.4 Network Barriers, they found out that during the period of funding the collaboration did not lead to an increase in research productivity. Although, the funding had more significant direct influence on research productivity.

Former research has shown that attaining funding and reducing risks is important. Also, some former research suggests costs and risks sharing is not that important and some other factors such as access to complementary knowledge are more important. Considering the findings regarding to the importance of other factors, the following hypothesis is presented.

H6. Cost and risk benefits are not associated with project success

3.3.2 Networking experience

The connection between collaboration and improved R&D has been proved in former research (e.g. Belderbos et al. 2004; Sakakibara 1997). It has also been shown that SMEs may have difficulty with partnering (Kirkels & Duysters 2010; Narula 2004) and generally lack experience in networking (Mancinelli & Mazzanti 2009; Nunes et al. 2010) and to benefit from R&D projects (Rosenbusch et al. 2011). Ahuja (2000) defines social capital as the firm's prior relationships with other firms which enhances firm's possibility to enter into new linkages. Networking experience is therefore cumulative and improves SMEs' probability to enter into new R&D collaborations.

Hernan et al. (2003) investigated determinants of research joint venture formation in Europe. One of their findings is that past participation in programmes positively influenced the probability to form a new research joint venture. Luukkonen (1998) points out that earlier skills and capabilities in international R&D collaboration were important to utilize the opportunities in the EU research programmes. And EU collaboration did not limit other international collaboration. Instead, participating EU projects improved the skills needed in international collaboration (both technical and social) and also facilitated future collaboration efforts.

Kang and Park (2012) results implied that international partnerships were more effective than domestic ones. SMEs with domestic and international partnerships performed significantly better in terms of innovation output than their counterparts without collaboration. As mentioned in subchapter 3.2.2 Irrelevance, Luukkonen (2000) suggested that EU funding programmes had more important role by providing

possibilities for new informal contacts and possibilities for exchange, otherwise deemed difficult to achieve.

Findings of Rosenbusch et al. (2011) show that SMEs benefit significantly more from a strategic innovation orientation than only from developing new products. This means SMEs can benefit by communicating and developing their innovation orientation which for example can lead to positive perception by market participants and rise their brand equity. By showing their innovation orientation SMEs can obtain better collaboration partners and attract highly skilled labor.

H7. Networking benefits are positively associated with project success

3.3.3 New knowledge and resources

Collaboration between different organizations is proved to improve R&D productivity in previous research (Belderbos et al. 2004; Sakakibara 1997). In general, SMEs need to rely on technological developments outside the company more than large companies (Hicks & Hedge 2005). It is also acknowledged that private sector firms' investment in R&D plays a crucial role for the discovery of new technologies and also for their diffusion (Hottenrott & Lopes-Bento 2014). State intervention strives to improve dissemination of information among the actors and hence enabling changes in the knowledge bases, improving codification and transferability of knowledge, and distributing knowledge through collaboration in the projects (Bach et al. 2014).

As mentioned in subchapter 3.3.1 Reduced costs and risk sharing, Bach et al. (2014) emphasize the importance of policy makers to understand the critical role of complementary knowledge rather than cost sharing in EU funded programmes. More precisely, they stress the importance of consortia involving participants from diverse industries and sectors which they claim has a positive effect on outcomes. Mancinelli and Mazzanti (2009) found a connection between diversified network activities and innovation. Complementarity was especially found to be more crucial for product innovations and radical innovations in contrast to process innovations. Sakakibara (1997) also has similar evidence. Sharing of complementary knowledge was perceived as the most important objective of Japanese R&D consortia. Technology spill-overs were not considered as severe problems and technology leaders were participating in the consortia. Narula (2004) lists access to complementary technologies important for both the SMEs and big companies.

Besides striving to access complementary knowledge, firms participate EU funded projects to explore new technological opportunities and to keep up with technological development (Bach et al. 2014). Mialhe et al. (2012) results from health field research in EU funded programmes showed that access to multidisciplinary academic expertise was considered an important factor by 86% of the respondents. The possibility of

tackling large scale research not achievable in the respondents own organization or country was also proven an important factor by 79% of the respondents. Triguero et al. (2013) findings regards to eco-innovation companies around Europe show that collaborative networks with universities, research institutes and agencies are essential to enhance eco-innovation of all types. They suggest that managers should be conscious of the possibility to use these innovation networks to enhance their innovation strategy.

Bach et al. (2014) propose that R&D cooperation through subsidy could be an efficient way to modify the absorptive capacity of firms, such as capacity to integrate, assimilate and recombine internal and external knowledge to address organizational and technical issues. According to Bach et al. easing access to new assets and combination of complementary assets and knowledge create new value. Mialhe et al. (2012) survey on Health industry showed also the importance of the availability of special resources and infrastructures, important for 61% of the respondents. Hottenrott and Lopes-Bento (2014) mention direct access to foreign market related knowledge as one benefit of international R&D collaboration. They suggest that international R&D collaboration may particularly benefit firms which are active in global markets.

SMEs can gain information through networking and project participations. This includes also sharing of complementary knowledge and resources, access to multidisciplinary academic expertise, access to new assets and special resources, and access to foreign market related knowledge. The project may also enable staff exchange and reinforced outward perspectives of learning by delegating staff to partner organizations (Haour 2004, 134). Access to new knowledge and resources is widely considered a crucial benefit for project outcomes leading to the following hypothesis.

H8. Knowledge and resource benefits are positively associated with project success

3.4 SME control and background factors

This subchapter presents the SME control variables and background factors for the model. SME size and R&D intensity are presented in subchapter 3.4.1. Previous experience, limited resources and absorptive capacity are presented in subchapter 3.4.2.

3.4.1 Control factors: SME size and R&D intensity

Bigger firm size and higher R&D intensity have been seen a benefit for inter-firm collaboration and also in some extend for innovation performance in former research. Herstad et al. (2014) find out that collaboration is driven by the size of the firm, its R&D intensity and by public funding. According to Kim and Vonortas (2014) young and small firms' have higher probability to engage in alliances as they grow in size. Negassi (2004) found out that the success of innovations of French companies depended mainly on size, R&D intensity, market share and human capital. The research also

highlights the ability of a firm to integrate external knowledge through absorptive capacity. However, Radas and Božić (2009) found out that proportion of full-time employees engaged in R&D did not have any relationship with innovation.

Chang and Chen (2004) research of Taiwanese SMEs showed that bigger firm size is positively related to market introduction of new products in publicly funded projects. The number of R&D personnel also had a significant positive effect on innovation according to their results. Nunes et al. (2010) investigated service SMEs in Portugal. For low-tech Portuguese service SMEs, they found out a negative statistically significant relationship between firm growth and R&D intensity. For high tech-firms the relationship was quadratic, and R&D was found to be restrictive determinant of growth until certain level after which it becomes positive determinant of growth.

Kang and Park (2012) results in South Korean biotechnology sector show that internal R&D resources (measured by spending and personnel) improve innovation performance both directly and indirectly by improving absorptive capacity of the firm to acquire knowledge from external sources. They also found a significant positive correlation between R&D resources and collaboration with domestic upstream partners, international upstream partners and domestic downstream partners. Kim and Vonortas (2014) empirically analyzed factors related to willingness of small young companies to participate in collaborative agreements. Their results show that firms are more likely to engage in collaboration as they are more innovative.

From these insights it can be concluded that firm size and R&D intensity may enhance project success. The hypotheses H10 and H11 are presented below.

H10. SME Size of the firm is positively associated with project success
H11. SME R&D intensity is positively associated with project success

3.4.2 Previous experience, limited resources, absorptive capacity

Furthermore, three more SME background related hypotheses H12, H13 and H14 are added based on subchapter 2.2 Characteristics of SMEs. The general lack of experience in R&D collaboration and importance of previous experience of SMEs has been highlighted in previous research (Hottenrott & Lopes-Bento 2014; Kim & Vonortas 2014; Rosenbusch et al. 2011). Therefore, it can be suggested that the SMEs with more experience have better capabilities to be successful in the projects.

The general problem of SMEs facing limited resources (Hausman 2005; Thorpe et al. 2005; Chang & Chen 2004; Narula 2004) is considered to constrain successful outcomes. The projects are demanding in terms of resources for administration and taking part into the projects. SMEs are claimed to lack the knowledge base to absorb the required knowledge (Kirkels & Duysters 2010) and higher absorptive capacity is

considered to improve innovation performance (Kang & Park 2012). This suggests that SMEs with higher capability to absorb external knowledge are more successful.

H12. SME previous experience is positively associated with project success
H13. SME limited resources are negatively associated with project success
H14. SME applying external knowledge is positively associated with project success

3.5 Model and hypotheses

This subchapter presents a model based on literature findings of the chapters 2 and 3. The model provides a conclusion of the most essential literature findings. After presenting the model there will be a conclusion of the hypotheses created in line with literature. These hypotheses will further be tested in the following chapters. The model is presented in the following Figure 2.

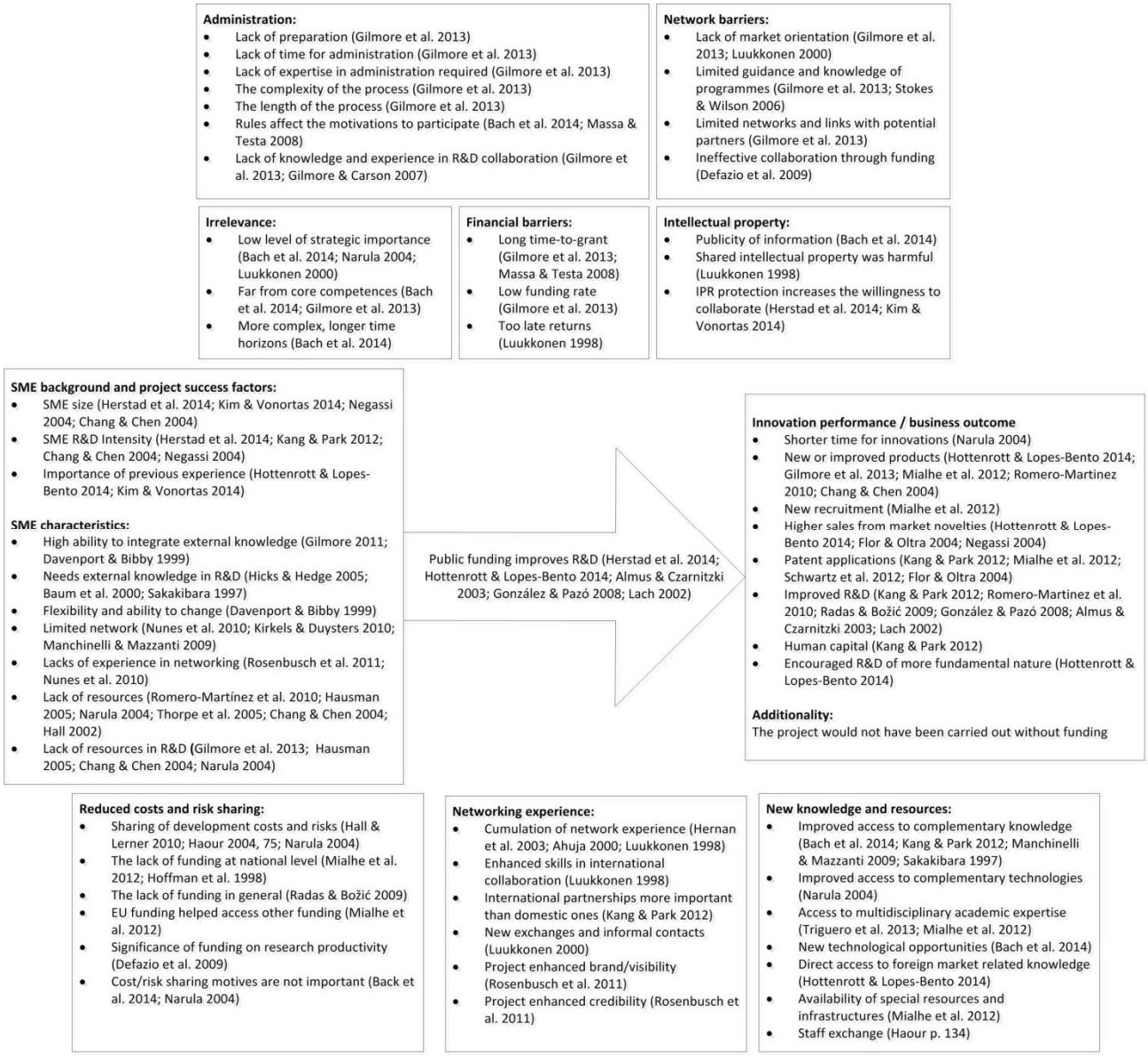

Figure 2. *Factors of SME project success in publicly funded R&D projects*

Figure 2 shows the background factors of SMEs (SME background and project success factors, SME characteristics), barriers for the project success (Administration, Irrelevance, Financial barriers, Network barriers, and Intellectual property) and the benefits possibly enhancing project success (Reduced costs and risk sharing, Network experience, and New knowledge and resources). The measures of project success (based on the listing of Table 1 in subchapter 2.3) are presented on the right side. The list of the hypotheses is provided separately in the following Table 2.

Table 2. *List of the hypotheses of project success*

Hypothesis		*Relation with Project Success*
H1	*Administration barriers*	*negatively associated*
H2	*Irrelevance barriers*	*negatively associated*
H3	*Financial barriers*	*negatively associated*
H4	*Network barriers*	*negatively associated*
H5	*IPR barriers*	*negatively associated*
H6	*Cost and risk benefits*	*not associated*
H7	*Networking benefits*	*positively associated*
H8	*Knowledge and resource benefits*	*positively associated*
H10	*SME size of the firm*	*positively associated*
H11	*SME R&D intensity*	*positively associated*
H12	*SME previous experience*	*positively associated*
H13	*SME limited resources*	*negatively associated*
H14	*SME applying external knowledge*	*positively associated*

Table 2 shows the hypotheses regarding to the experiences during the project (H1-H8) and the SME background factors (H10-H14). The hypotheses generally follow the logic that barriers affect project success negatively and benefits affect it positively. The only exception is cost and risk benefits which have received conflicting evidence in the previous literature and are not perceived to have a significant linear association with project success. The first eight hypotheses are based on the conditions during the projects and the last five hypotheses are related to SME background. These hypotheses will be tested empirically in the following chapters.

4. RESEARCH METHOD AND DATA

This chapter describes in detail the method of preparing the questionnaire, the process of collecting the responses from the SMEs around Europe and achieving the final sample of 711 responses (subchapters 4.1 and 4.2). After this the background details of the final sample are presented in subchapter 4.3. The subchapter 4.4 shows operationalization of variables through exploratory factor analyses for dependent project success variables and independent project barrier, project benefit and SME background variables leading to the final variable structures. The updated hypotheses and the final model are presented in subchapter 4.5. Data analysis (subchapter 4.6) discusses the required assumptions for linear regression analyses.

4.1 Preparation of the questionnaire

The survey variables and questions (Appendix A) were created based on the bullet points of literature review model and the hypotheses presented in chapter 3. The unit of analysis was an SME which has participated in collaborative R&D projects funded by European Commission and related sources and the level of analysis was the participation in the most recent project (Seventh Framework Programme, Eureka, or Eurostars). Asking respondents to answer based on one project was chosen to improve comparability of answers (answers about participation in many projects are not comparable with answers concerning only one project). The most recent project was chosen to avoid social desirability bias towards successful projects.

Multi-item Likert-scales were used for the dependent variables (Project success variables) and most of the independent variables (questions related to experienced barriers, benefits, SME characteristics, and previous experience). Likert-type scale (1 = Strongly Disagree … 5 = Strongly Agree) was used for the statements regarding to experiences of barriers, benefits and perceived SME characteristics. Likert-scale was also used for previous experience of similar projects (1 = Never … 5 = Very Often) and Project success variables related to outcomes of the project (1 = Not at all … 5 = A Great Deal). The questionnaire was tested and the validity of items was improved with a test group of one SME (previously participated in one FP7 project) and colleagues at CERN. Testing and improving the questionnaire took place in three iteration rounds.

To confirm the answering companies are SMEs two questions were asked: 1) Company type (SME, Big company, Other) and number of staff (0–9, 10–49, 50–249, 250–).

Some other background questions include Staff in R&D, business sector, country, main role of answering person, and the most recent project. Business sector classification was created by following the classification of SMEs by Eureka programme. Management Consulting was added on the list based on the comments of the test group.

The list of main roles of answering person was created while collecting the contact details of SMEs. It also turned out that many of the project participant SMEs are academic spin-offs originating from universities. This is why a question regarding to whether company is an academic spin-off was added. Two open questions were provided for comments regarding to the funding instruments and the survey. The answering person was also able to leave contact details to receive the research results.

4.2 Target group and survey responses

The survey had a target group of 10 000 companies with the main focus in 11 European Union member states. The member states were selected based on more developed innovation system, better visibility of SMEs and generally higher amount of available R&D funding. These 11 member states were Germany, United Kingdom, Italy, France, the Netherlands, Belgium, Sweden, Denmark, Norway, Finland and Estonia. The lists of the SMEs were received from Finnish national funding agency Tekes (7th Framework Programme), and Eureka network participant search (Eurostars and Eureka projects from 2004–). The email addresses were collected in the internet by hand (priority was CEO contact) according to the company name lists between May and August 2014. Found contacts and the response rates are presented in the following Table 3.

Table 3. *The population and the sample of project participant SMEs*

	Target group	Searched	Found	Duplicates	Responded	Response rate
FP7/Germany	1811	1618	1309 (80.90%)	10	124	9.55 %
FP7/UK	1626	1227	980 (79.87%)	3	96	9.83 %
FP7/Italy	1235	695	569 (81.87%)	1	50	8.80 %
FP7/France	1088	542	399 (73.62%)	0	26	6.52 %
FP7/Netherlands	769	769	622 (80.88%)	8	58	9.45 %
FP7/Belgium	474	474	391 (82.49%)	1	47	12.05 %
FP7/Sweden	419	419	384 (91.65%)	0	67	17.45 %
FP7/Denmark	296	296	265 (89.53%)	2	36	13.69 %
FP7/Norway	252	252	224 (88.89%)	1	28	12.56 %
FP7/Finland	237	237	230 (97.05%)	0	37	16.09 %
FP7/Estonia	91	91	87 (95.60%)	1	5	5.81 %
FP7/Other	0	0	0		44	
FP7 total	**8298**	**6620**	**5460 (82.48%)**	**27**	**618**	11.37 %
Eureka	N/A	2973	2697 (90.72%)	251	131	5.36 %
Eurostars	N/A	642	502 (78.19%)	9	84	17.04 %
Eureka total	**N/A**	**3615**	**3199 (88.49%)**	**260**	**215**	7.32 %
ALL	12000+	10235	8659 (84.60%)	287	833	9.95 %

The survey was sent by SurveyMonkey online survey software and the survey was first mailed on July 2, 2014. Responses were collected gradually while searching the remaining contact details. The last reminder was mailed on August 12, 2014.

The lists received from Tekes included names of the 8298 SMEs which had participated in FP7 from the mentioned 11 countries. Contact details for Eureka and Eurostars SMEs were collected from all the participating countries since their amount was lower (total collected 3615). All the contacts (e-mail addresses) were collected by hand with a finding percentage of 84.60%. Due to lack of resources for finding the contacts the amount of contacts searched was limited to a little over 10 000. The amount of found contacts was a total of 8659 including 5460 FP7 contacts and 3199 Eureka and Eurostars contacts. The survey was sent to these 8659 contacts. During the answer collection period 833 responses were received (with a response rate of 9.95%). Table 3 shows that the response rates differed depending on the country. The highest response rates were in Sweden (17.45%) and Finland (16.09%) and some of the lowest response rates were in France (6.52%) and Estonia (5.81%). The response rate for Eureka projects (5.36%) was relatively low.

There were also 44 responses which were not from the listed 11 countries and had participated in FP7 programmes. This implies that some of the Eureka or Eurostars participants may have had their most recent project in FP7. The lists included duplicates in found contacts. In some cases, this was caused by ownership of two different SMEs by the same person. In terms of the total 8659 mailed contacts 434 rejected the message. This suggests that actual sent was only 8225 and the real response rate could increase to 10.13%. In addition, 224 (2.72%) unsubscribed the survey. In a few cases the email addresses were not valid and the respondent claimed they had not participated in any programmes. Programme officials had made some wrong classifications and their lists of SMEs included also some large companies. The contact details were not collected if two or more companies had the same name. The sample of 833 responses also included discontinued responses, several organizations which are not SMEs, and responses given without thinking. The responses are classified according to the amount of discontinued answers in the following Table 4.

Table 4. *Responses classified by discontinuity rate*

Empty answers	91%-100%	81%-90%	71%-80%	61%-70%	51%-60%
N	0	44	10	12	3
	41%-50%	31%-40%	21%-30%	11%-20%	0%-10%
total 833	5	0	11	0	**748**

Responses with more than 10% empty answers were excluded from the sample. After the reduction the sample includes 748 responses. The next Table 5 shows the classification of the remaining responses by Number of staff and Company type.

Table 5. *Remaining responses classified by number of staff and company type*

Number of staff	0-9	10-49	50-249	250-
SME	**354**	**266**	**102**	1
Big company	0	1	1	8
Other	6	3	2	4

Definition states that SMEs have less than 250 employees. One respondent answered that they are an SME with 250 or more staff. There were also big companies with staff less than 250. Answers also included eight real big companies and other organizations. The list of the answers given to other is presented in the following Table 6.

Table 6. *The other organizations in sample*

Other, which?
Cluster organisation
Non-profit organization, Research Institute
NGO
SME association
University
individual company (1 people)
Academic
Trade Association
non-profit
non governmental organization
Large
NGO
University
Association and SME
cluster of SMEs and big companies, university and public sector

Based on these two questions only SMEs with the size of 249 and less (bold in the chart) were left into the sample. Big companies, Others and answers of 250– staff were excluded leaving 722 responses in the sample. Finally the non-thought answers (many answers per one number) were found by recognizing the responses in which the respondent had answered more than half of the Likert-scale answers on one number. The frequencies of found responses is presented in the following Table 7.

Table 7. *Potential non-thought answers in the sample*

>50%	50-60%	60-70%	70-80%	80-90%	90-100%
38 (N=722)	26	3	4	2	3

Each of these responses was reviewed individually to clarify whether answers on one number are continuous or dispersed. A total amount of 11 answers was excluded leaving the final sample of 711 responses.

4.3 Background information on the respondents

This subchapter presents the background information of the respondents in the final sample. The final sample includes 711 responses which all are SMEs and have a maximum of 10% empty answers. The Business Sectors of the respondents are presented in the following Table 8. The classification of business sectors is based on Eureka programme classifications of SMEs with addition of Management Consulting sector

Table 8. *Business sector of respondents in the final sample*

Business Sector		
	Frequency	%
Electronics, IT and telecoms technology	174	24.5
Industrial manufacturing, material and transport	89	12.5
Other industrial technologies	39	5.5
Energy technology	44	6.2
Chemistry, physical and exact sciences	29	4.1
Biological and medical sciences	110	15.5
Agriculture and marine resources	24	3.4
Agrofood technology	11	1.5
Measurements and strandards	14	2.0
Technology for protecting man and the environment	33	4.6
Management Consulting	25	3.5
Other	118	16.6
N = 710 (missing 1)		

Table 8 shows that the most common sectors were Electronics, IT and telecoms technology (24.5%) and Biological and medical sciences (15.5%). Agrofood technology (1.5%) had the smallest amount of respondents. The next Table 9 presents the numbers of staff and R&D intensities of the respondents in the sample.

Table 9. *Number of staff and R&D intensity of the respondents in the final sample*

Number of Staff			**R&D Intensity**		
	Frequency	%		Frequency	%
0-9	350	49.2	0%	33	4.6
10-49	262	36.8	1-25%	272	38.3
50-249	99	13.9	26-50%	131	18.4
			51-75%	142	20.0
N = 711			76-100%	133	18.7

Most of the SMEs were small. Nearly half of the respondents are microenterprises (49.2%) with fewer than 10 employees. Employees working in R&D were most commonly less than a quarter of the company size. The next Table 10 shows the background information on the most recent project participations and the prevalence of academic spin-offs among the respondents.

Table 10. *Details of the most recent project and orientation to academic research*

The most recent project			**Business is mainly based on academic research**		
	Frequency	%		Frequency	%
FP7	535	75.2	Yes	196	27.8
Eurostars	71	10.0	No	509	72.2
Eureka	105	14.8	Don't know	6	
N = 711					

Table 10 shows that the most of the respondents participated in FP7 project (75.2%). The business of majority of the respondents (72.2%) is not directly based on academic research. However, academic spin-offs have distinguishable prevalence (27.8%). The following Table 11 shows the main roles of the answering persons.

Table 11. *The main roles of the answering person*

Main role of the answering person		
	Frequency	%
CEO, Chief Executive Officer/Managing Director	241	33.9
CEO & Owner	201	28.3
Owner	31	4.4
CFO, Chief Financial Officer	11	1.5
COO, Chief Operating Officer	16	2.3
CTO, Chief Technology Officer	33	4.6
Chairman of board	9	1.3
Marketing director	14	2.0
head of R&D	44	6.2
Project manager	68	9.6
secretary	5	.7
Other	38	5.3
N = 711		

The most common roles were Chief Executive Officer and CEO owner. Together they constitute 62.2% of the responses. The next Table 12 presents the countries of the respondents.

Table 12. *Countries of the respondents in the final sample*

Country of the company/unit								
	Frequency	%		Frequency	%		Frequency	%
Austria	2	0.3	Iceland	1	0.1	Romania	3	0.4
Belgium	46	6.5	Ireland	1	0.1	San Marino	1	0.1
Croatia	1	0.1	Israel	3	0.4	Serbia	4	0.6
Cyprus	2	0.3	Italy	47	6.6	Slovakia	1	0.1
Czech Republic	20	2.8	Latvia	3	0.4	Slovenia	19	2.7
Denmark	40	5.6	Lithuania	6	0.8	Spain	24	3.4
Estonia	7	1.0	Luxembourg	1	0.1	Sweden	78	11.0
Finland	38	5.3	Malta	1	0.1	Switzerland	7	1.0
France	23	3.2	The Netherlands	63	8.9	Turkey	2	0.3
Germany	117	16.5	Norway	37	5.2	United Kingdom	91	12.8
Greece	6	0.8	Poland	1	0.1	Other	2	0.3
Hungary	7	1.0	Portugal	6	0.8	**Total**	**711**	**100**

Table 12 shows that some countries have only a few respondents. Germany (117), United Kingdom (91) and Sweden (78) have the highest number of respondents.

4.4 Operationalization of variables, and testing of variable structures

The multi-item variables were developed based on previous research (refer to model in subchapter 3.5 and questionnaire form in appendix A). The unit of analysis was an SME which has participated in the R&D projects funded by European Commission and related sources. The level of analysis is the participation in the most recent FP7, Eureka or Eurostars project. Likert-scales were used for multi-item dependent project success variables and the independent variables on experienced barriers, benefits and perceived SME characteristics and previous experience variables. Exploratory factor analyses through principal components analysis with Varimax rotation were conducted in order to test the variable structures for the dependent variables and the independent variables. There were some overlaps between the variables. Only the items which loaded the highest on the principal component were included. Cronbach's Alphas were calculated to estimate internal consistency of the scales. Component scores below 0.3 were omitted in the presented factor model tables. The inconsistent items were excluded.

The factor model operated well for the dependent project success variable (MSA 0.87, with 54% of the variance explained). The project success variable is constituted of seven items which deal with outcomes of the publicly funded projects (Cronbach's alpha 0.86). Patent applications were excluded (Table 17). The project success variable combines subjective measures with relatively more objective measures which are believed to yield more insights (Romin & Albaladejo 2002). The items were collected and created based on previous research (Hottenrott & Lopes-Bento 2014; Gilmore et al. 2013; Kang & Park 2012; Mialhe et al. 2012; Schwartz et al. 2012; Romero-Martinez et al. 2010; Radas & Božić 2009; González & Pazó 2008; Chang & Chen 2004; Flor and Oltra 2004; Negassi 2004; Narula 2004; Almus & Czarnitzki 2003; Lach 2002). The structure of dependent Project Success variable is presented in the following Table 13.

Table 13. *Factor structure for the dependent variable on project success*

Dependent variable on Project Outcomes

Project Success, Cronbach's Alpha 0.86	
Shorter time for innovations	0.68
New or improved products	0.76
New recruitment	0.69
Higher sales from market novelties	0.72
Improved R&D	0.82
Improved human capital	0.78
Encouraged more fundamental R&D	0.71

The factor model operated well also for the independent variables on project barriers (MSA 0.85, with 67% of the variance explained). There were some changes concerning the initial literature model. The original administration barriers were divided into two different variables (Administration barriers and Knowledge barriers). Administration Barrier consists of five items measuring the difficulties concerning the project administration during the project (Cronbach's alpha 0.85). These items were collected and modified from previous research (Bach et al. 2014; Gilmore et al. 2013; Massa & Testa 2008). Initially, limited knowledge and guidance of programmes presented by Gilmore et al. (2013) and Stokes and Wilson (2006) was classified with network barriers, but in the principal component analysis it loaded together with the administration barriers.

Knowledge Barriers consists of three items (Cronbach's alpha 0.81). This is a new variable suggested by the principal component analysis. All of the three items of knowledge barriers are based on administration barriers (lack of knowledge and expertise in R&D collaboration, lack of expertise and competences to contribute towards project goals, lack of preparation) and were formed in line with previous literature (Gilmore et al. 2013; Gilmore et al. 2006). Project Scale and Inefficiency Barrier variable consists of five items (Cronbach's alpha 0.76). This is also a new variable created based on principal component analysis and has items initially classified into financial barriers (project budget was too extensive), network barriers (partners from too many countries, inefficient collaboration, lack of market orientation), and administration barriers (lack of expertise in R&D collaboration which was measured by ambitiousness of technological perspective). These items were based on former research (Gilmore et al. 2013; Kang & Park 2012; Defazio et al. 2009; Gilmore et al. 2006; Luukkonen 2000).

Irrelevancy of Project Barrier is based on three items with respect to the strategic importance, irrelevancy of project, and relation with core competences of the firm (Cronbach's alpha 0.82). All of these items are based on former literature (Bach et al. 2014; Gilmore et al. 2013; Narula 2004; Luukkonen 2000). Money barriers consists of three items regarding to the share of funding, time to receive money and returns of the project (Cronbach's alpha 0.68). These items originate from previous research (Gilmore et al. 2013; Massa & Testa 2008; Luukkonen 1998). Intellectual property and publicity of information is based on two items (Cronbach's alpha 0.71). These items concern the harmfulness of project information publicity and the role of intellectual property found in literature (Bach et al. 2014; Herstad et al. 2014; Kim & Vonortas 2014). The last three variables (Irrelevance, Money, IPR issues) were fairly consistent with the initial literature model. One item regarding to project time horizon was excluded (Table 17) and Network barriers were mixed with the other variables. The next Table 14 shows the independent project barrier variables, their component scores and reliability coefficients.

Table 14. *Factor structure for the independent variable on project barriers*

Independent variables on Barriers during the project	Component					
	1	2	3	4	5	6
Barrier: Administration, Cronbach's Alpha 0.85						
The project's administration was too complex	0.90					
The project administration required too much time	0.85					
The funding agency participation requirements lower the motivation to take part in projects	0.78					
The company lacked expertise in the administration required	0.65		0.34			
The company had limited guidance and information from funding agency during the project	0.52	0.32	0.32			
Barrier: Project Scale & Inefficiency, Cronbach's Alpha 0.76						
The project budget was too extensive results could be reached with a smaller budget		0.71				
The project had partners from too many countries		0.69				
The cooperation between partners was ineffective during the project		0.65				
The project was too ambitious from technological perspective		0.60				
The project lacked market orientation		0.56		0.41		
Barrier: Knowledge, Cronbach's Alpha 0.81						
The company lacked knowledge and experience in R&D collaboration to fully contribute towards the project goals			0.90			
During the project the company lacked expertise and competences to fully contribute towards the project goals			0.86			
In general, the company and its personnel should have been more prepared before the start of the project			0.70			
Barrier: Irrelevancy of project, Cronbach's Alpha 0.82						
The strategic importance of the project was low to our company				0.85		
The project was irrelevant to the company's objectives				0.82		
The project was far from the company's core competences				0.76		
Barrier: Money, Cronbach's Alpha 0.68						
The company's own share of funding was too high in the project					0.77	
The time to receive money from the funding agency/agencies was too long					0.74	
The project had too long time before possible revenues based on the project					0.68	
Barrier: IPR issues and publicity of information, Cronbach's Alpha 0.71						
Opening up the project results and documentation to public domain was/is harmful to our company						0.88
The joint IPR ownership scheme in the project was/is harmful for the company's business in the long run						0.80

The factor model worked well for the independent variables on project benefits (MSA 0.85, with 65% of the variance explained). Knowledge transfer benefit variable consists of eight items (Cronbach's alpha 0.83). These items are based on previous literature regarding to the benefits of knowledge complementarity, improved access to complementary technologies, access to academic expertise, new technological opportunities, access to foreign market related knowledge and availability of special infrastructures and resources (Bach et al. 2014; Hottenrott & Lopes-Bento 2014; Triguero et al. 2013; Kang & Park 2012; Mialhe et al. 2012; Mancinelli & Mazzanti 2009; Narula 2004; Sakakibara 1997). Networking benefits variable consists of two items concerning improved networking capabilities and enhanced international collaboration (Cronbach's alpha 0.80). These items are based on previous research (Hernan et al. 2003; Ahuja 2000; Luukkonen 1998). The five overlapping items were included in knowledge transfer variable because of their involvement with external information, knowledge, technologies and academic expertise (4 items) and since intensity of collaboration is not directly concerned with skills in networking (1 item).

Brand benefits is a new variable suggested by the principal component analysis and separated from network benefits. Brand benefits consists of two items concerning enhanced brand and enhanced credibility (Cronbach's alpha 0.78). These benefits were derived from the ideas of Rosenbusch et al. (2011). Sharing costs and risks benefit variable consists of two items (Cronbach's alpha 0.87). These items are based on previous literature of the cost and risk sharing benefits and motives in the projects (Bach et al. 2014; Hall & Lerner 2010; Haour 2004, 75; Narula 2004). Four items of the project benefits were excluded (Table 17). The following Table 15 presents the factor structure for the independent variables on project benefits.

Table 15. *Factor structure for the independent variable on project benefits*

Independent variables on Benefits during the project	Component			
	1	2	3	4
Benefit: Knowledge Transfer, Cronbach's Alpha 0.83				
The project allowed new exchanges of information otherwise deemed impossible to achieve	0.51	0.40		
The project improved the company's overall intensity of external collaboration	0.57	0.38		0.32
The project improved the company's access to complementary knowledge	0.58	0.57		
The project enhanced access to complementary technologies	0.36	0.63		
The project improved access to pertinent academic expertise	0.57	0.34		
The project brought up new technology adoption opportunities		0.69		
The project allowed direct access to foreign market related knowledge		0.64		
The project enhanced access to special resources and infrastructures, important for the company		0.76		
Benefit: Networking, Cronbach's Alpha 0.80				
The project improved capabilities in networking	0.80			
The project enhanced skills to collaborate internationally	0.78			
Benefit: Brand, Cronbach's Alpha 0.78				
The project enhanced our brand and/or visibility				0.83
The project enhanced our credibility				0.84
Benefit: Sharing Costs & Risks, Cronbach's Alpha 0.87				
Given the project targeted outcome (technology, product etc.), it was important to share development costs with the other participants			0.92	
Given the project targeted outcome (technology, product etc), it was important to share the risks with the other participants			0.92	

The factor model also worked well for the independent variables on SME characteristics and perceived background factors (MSA 0.72, with 64% of the variance explained). SME experience is constituted of four items (Cronbach's alpha 0.81). These items relate to the literature highlighting the importance of previous experience in R&D collaborations (Hottenrott & Lopes-Bento 2014; Kim & Vonortas 2014). SME limited resources consists of four items (Cronbach's alpha 0.67). These items were created based on earlier research on characteristics of SMEs (Gilmore et al. 2013; Romero-Martínez et al. 2010; Rosenbusch et al. 2011; Nunes et al. 2010; Hausman 2005; Thorpe et al. 2005; Chang & Chen 2004; Narula 2004; Hall 2002).

SME applying external knowledge variable consists of two items (Cronbach's alpha 0.68). These are based on research suggesting SMEs have a high ability to integrate external knowledge and they need external knowledge in R&D (Gilmore 2011; Davenport & Bibby 1999; Hicks & Hedge 2005; Baum et al. 2000; Sakakibara 1997).

SME low funding availability is based on two items (Cronbach's alpha 0.64). Although, these items were initially presented with financial barriers in the literature part, they are more background factors than attributes of a project. Lack of funding at national level and lack of funding in general was expressed in some previous research (Mialhe et al. 2012; Radas & Božić 2009; Hoffman et al. 1998). Two SME background items were excluded (Table 17). The following Table 16 shows the independent variables on SME background.

Table 16. *Factor structure for the independent variable on SME background*

Independent variables on SME background	Component			
	1	2	3	4
SME Experience, Cronbach's Alpha 0.81				
acted as a lead partner/coordinator in collaborative R&D project	0.83			
previously participated in national funding programmes	0.78			
previous experience in the administration of a similar project	0.78			
earlier R&D collaboration with external companies/universities	0.76			
SME Limited resources, Cronbach's Alpha 0.67				
The company lacks experience in networking (with universities, other companies etc)		0.80		
The company lacks awareness to external sources of finance		0.72		
We have a limited external network of universities and companies		0.65		
The company lacks resources (staff, materials, knowledge, etc)		0.61		
SME Applying External Knowledge, Cronbach's Alpha 0.68				
The company has a high ability to integrate external knowledge			0.86	
The company constantly applies external knowledge in R&D			0.86	
SME Low Funding Availability, Cronbach's Alpha 0.64				
There is low availability of external private funding in the country where the company is registered				0.85
There is low availability of suitable national public funding in the country where the company is registered				0.84

All the factor models initially had some excluded items. The most common reasons for item exclusion were inconsistency in a rotated component matrix and low Cronbach's alpha when testing with other items. Project benefits had the most excluded items. All the excluded items are provided in the following Table 17.

Table 17. *Excluded items in the factor models*

Excluded Variables	**Reason of Exclusion**
Independent variables on SME background	
Collaboration in the project was based on former links/relations	inconsistency in rotated component matrix
We have low bureaucracy inside the company	low Cronbach's Alpha (0.518)
Independent variables on Barriers during the project	
The project had too long time horizon to completion	inconsistency in rotated component matrix
Independent variables on Benefits during the project	
The project helped to access other sources of funding	inconsistent
In general, international partnerships are more important than domestic ones	inconsistent
The project allowed staff exchange and staff secondments (to partner firms, universities, etc.)	inconsistent
The project partners were represented from multiple industry sectors	low Cronbach's Alpha (0.65), inconsistent
Dependent variables on Project Outcomes	
Patent applications	inconsistent

The consistency of the variables was generally good. The variables mostly include items loading to the factors with Cronbach's alpha more than 0.7. The four exceptions with lower Cronbach's alpha are Money barriers (0.68), SME limited resources (0.67), SME applying external knowledge (0.68), and SME low funding availability (0.64). The values of the variables were calculated by calculating the mean value of the items included into the variable (the items were all Likert-type scale 1–5). Knowledge transfer and networking benefit variables had some overlapping items which were included into knowledge transfer variable.

4.5 Final model and hypotheses

The principal component analyses proposed five main changes to the initial setting constructed in chapters 2 and 3. (1) Administration was divided into two variables, Administration Barriers (H1a) and Knowledge barriers (H1b). (2) The items of Network barriers were mixed with other variables discontinuing the original Network Barrier variable. (3) One completely new Project Scale and Inefficiency variable (H15) was created. (4) Network benefit was divided into two variables, Network benefit (H7a) and Brand benefit (H7b). (5) Low availability of funding initially presented in financial barriers was moved to independent variables on SME background and added to the model (H16). The updated hypotheses are presented in the following Table 18.

Table 18. *Updated list of the hypotheses of project success*

Hypothesis		*Relation with Project Success*
H1a	***Administration barriers***	***negatively associated***
H1b	***Knowledge barriers***	***negatively associated***
H2	*Irrelevance barriers*	*negatively associated*
H3	*Financial barriers*	*negatively associated*
H5	*IPR barriers*	*negatively associated*
H6	*Cost and risk benefits*	*not associated*
H7a	***Networking benefits***	***positively associated***
H7b	***Brand benefits***	***positively associated***
H8	*Knowledge and resource benefits*	*positively associated*
H10	*SME size of the firm*	*positively associated*
H11	*SME R&D intensity*	*positively associated*
H12	*SME previous experience*	*positively associated*
H13	*SME limited resources*	*negatively associated*
H14	*SME applying external knowledge*	*positively associated*
H15	***Project scale and inefficiency barriers***	***negatively associated***
H16	***Low availability of funding***	***not associated***

The initial hypotheses were extended to the new ones. Administration barriers (H1a) and Knowledge barriers (H1b) are both considered negatively associated with project

success, consistent with the original hypothesis H1. Networking benefits (H7a) and Brand benefits (H7b) are considered positively associated with project success, consistent with H7. The Network barriers hypothesis was excluded. Project scale and inefficiency (H15) is based on items from financial barriers, network barriers and administration barriers. Based on the literature behind the items (Gilmore et al. 2013; Kang & Park 2012; Defazio et al. 2009; Gilmore et al. 2006; Luukkonen 2000) it is assumed that the association to project success could be negative. Low availability of funding (H16) originated from cost and risk benefits and hence is not considered to have a significant association with project success. The final model is presented in the following figure 3.

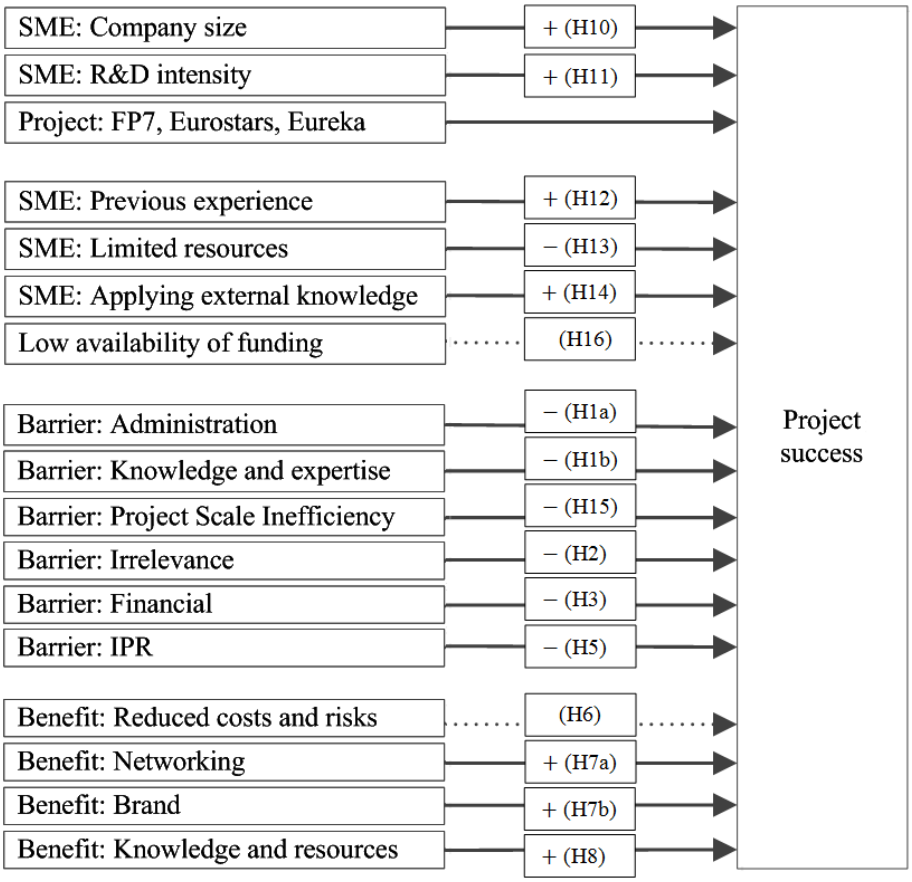

Figure 3. *The final model including the hypotheses*

The final model includes the updated and added hypotheses (H1a, H1b, H7a, H7b, H15 and H16). The expected impact on Project Success is indicated with pluses and minuses. The control variable regarding to project type (FP7, Eurostars, Eureka) was added into the model. Project type was coded into dummy variables to enable utilizing it in the following analyses.

4.6 Data analysis

The data analysis is conducted in two phases. To assess the properties of the data, the first phase determines the descriptive statistics and correlation coefficients. After this, the second phase of analysis is conducted with stepwise linear regression analyses testing the association between the dependent project success variable and the independent variables. The linear regression model includes four steps: first adding the control variables, then the variables regarding to SME background factors, then the project barrier variables, and finally the project benefit variables. Linear regression analyses were used since the variables mostly meet the required assumptions: variables are normally distributed, there is a linear relationship between the independent and dependent variables, variables are reliable, and residuals are mostly scattered evenly around the line.

The frequency distributions of variables are generally adequate. Most of the variables are normally distributed. Project Success, Administration Barriers, Project Scale and Inefficiency, Money Barrier, IPR Barrier, Knowledge Transfer Benefit, SME experience, SME limited resources, and SME low funding availability followed the shape of normal distribution. Knowledge Barrier, Network Benefit, Brand Benefit, and Cost and Risk Benefit followed the shape in some extent. Barrier Irrelevance and SME applying external knowledge followed normal distribution less perfectly.

Also the other assumptions are mostly fulfilled. Reviewing the individual plots between independent variables and dependent project success variable indicated mostly linear associations. Reliability of variables was generally good (Cronbach's alpha > 0.7, except four variables Cronbach's alpha > 0.6). The correlations between the independent variables and the dependent project success variable do not show visible heteroscedasticity problems, except slightly for SME applying external knowledge variable.

Further linear regression analyses are conducted to explain the mediating role of the project benefit variables. In these analyses the project benefit variables are dependent variables and independent variables include control factors, SME background variables and project barrier variables. These analyses also fulfil the required assumptions. The correlations were mostly linear and adequate for the analyses.

5. RESULTS

This chapter presents the results of the hypothesis testing and linear regression analyses between the dependent project success variable and the independent variables. The analysis is conducted based on the responses of the sample of 711 SMEs which have previously participated in international R&D projects. The hypotheses and variables are based on previous research (chapters 2 and 3) and were updated to achieve consistency with variable structures (chapter 4). Descriptive statistics and correlation coefficients are presented in the following subchapter 5.1. After this, the results of linear regression are reported in subchapter 5.2. Mediating role of benefits is explored in subchapter 5.3. There will be a summary of the hypothesis testing results in the end of the chapter.

5.1 Descriptive statistics

Descriptive statistics and correlation coefficients were calculated with the variables created in chapter 4 to assess the properties of the data (Table 19). Paying attention to the responses for SME background variables, the respondents seem to have high average experiences for applying external knowledge (4.12) and low availability of funding (3.29). On average, the respondent experiences on barriers are fairly low (between 1.87 and 3.02) while the experiences on benefits are fairly high (between 3.58 and 3.94). There is a slight negative correlation ($r = -0.19$, $p < 0.001$) between number of staff and R&D intensity. Small SMEs had generally higher R&D intensity in comparison with the bigger SMEs in the sample. The companies with higher R&D intensity experienced generally less irrelevance barriers ($r = -0.14$, $p < 0.001$) and knowledge barriers ($r = -0.21$, $p < 0.001$).

The respondents who perceived to have more previous experience generally experienced less limited resources ($r = -0.33$, $p < 0.001$). The respondents experiencing limited resources generally experienced more knowledge barriers ($r = 0.36$, $p < 0.001$) and money barriers ($r = 0.19$, $p < 0.001$). Experiencing one barrier is positively and significantly correlating with experiencing the other barriers ($0.18 < r < 0.55$, $p < 0.001$). SMEs experiencing one barrier may generally also experience the others. Experiencing one benefit is also positively and significantly correlating with experiencing the other benefits ($0.22 < r < 0.56$, $p < 0.001$). This indicates that the SMEs experiencing one benefit might generally experience the other benefits as well. Experiencing benefits correlates negatively but not in all cases significantly with experiencing barriers. Some of these correlations are very low and insignificant.

Table 19. *The descriptive statistics and correlation coefficients*

N = 711

	Mean	Std. Deviation	Number of staff	Staff in R&D	project FP7	project Eurostars	project Eureka	SME Experience	SME Limited Resources	SME Applying External Knowledge	SME Low Funding Availability	Barrier Administration	Barrier Project Scale and Inefficiency	Barrier Irrelevance	Barrierm Experience	Barrier IPR	Barrier Money	Benefit Knowledge Transfer	Benefit Networking	Benefit Brand	Benefit Cost and Risk
Number of staff	1.65	0.71																			
Staff in R&D	3.10	1.23	-0.19***																		
project FP7	0.73	0.45	-0.11**	0.02																	
project Eurostars	0.10	0.30	-0.01	0.07	-0.54***																
project Eureka	0.14	0.35	0.14***	-0.08*	-0.67***	-0.13***															
SME Experience	2.88	0.96	0.19***	0.19***	-0.08*	0.08*	0.03														
SME Limited Resources	2.59	0.78	-0.00	-0.13***	-0.05	-0.07	0.12**	-0.33***													
SME Applying External Knowledge	4.12	0.77	-0.02	0.18***	0.05	0.06	-0.11**	0.14***	-0.15***												
SME Low Funding Availability	3.29	0.92	-0.08*	0.10**	-0.06	-0.00	0.07	0.03	0.17***	-0.04											
Barrier Administration	3.02	0.86	-0.07*	-0.06	0.04	-0.03	-0.03	-0.18***	0.31***	-0.04	0.14***										
Barrier Project Scale and Inefficiency	2.33	0.71	0.01	-0.07	0.09*	-0.10**	-0.03	-0.14***	0.24***	-0.06	0.01	0.40***									
Barrier Irrelevance	1.87	0.73	0.06	-0.14***	-0.01	-0.04	0.05	-0.14***	0.23***	-0.16***	-0.01	0.24***	0.55***								
Barrier Knowledge	2.15	0.80	0.07*	-0.21***	-0.14***	0.02	0.15***	-0.14***	0.36***	-0.15***	0.02	0.32***	0.33***	0.28***							
Barrier IPR	2.47	0.84	-0.01	-0.03	-0.01	0.01	0.00	-0.03	0.12**	-0.09*	0.07	0.29***	0.27***	0.20***	0.19***						
Barrier Money	2.95	0.83	-0.05	-0.04	-0.05	-0.00	0.06	-0.06	0.19***	-0.06	0.14***	0.45***	0.37***	0.22***	0.18***	0.30***					
Benefit Knowledge Transfer	3.58	0.58	-0.04	-0.03	-0.00	0.02	-0.01	0.09*	-0.07	0.07*	-0.00	-0.21***	-0.32***	-0.32***	-0.01	-0.05	-0.13***				
Benefit Networking	3.94	0.76	-0.09*	0.01	0.13***	-0.10**	-0.08*	0.10**	-0.09*	0.00	-0.02	-0.19***	-0.17***	-0.18***	-0.00	-0.09*	-0.14***	0.56***			
Benefit Brand	3.89	0.74	-0.07	0.09*	0.11**	-0.04	-0.09*	0.11**	-0.13***	0.10**	-0.01	-0.20***	-0.26***	-0.33***	-0.12**	-0.14***	-0.12**	0.50***	0.44***		
Benefit Cost and Risk	3.86	0.86	-0.02	-0.03	0.10**	-0.04	-0.08*	0.05	0.01	0.07	0.05	-0.10**	-0.17***	-0.19***	-0.08*	-0.07	-0.05	0.34***	0.27***	0.22***	
Project Success	2.97	0.80	0.07	0.13***	-0.13***	0.09*	0.07	0.23***	-0.21***	0.10**	-0.03	-0.26***	-0.38***	-0.41***	-0.10**	-0.06	-0.15***	0.56***	0.42***	0.44***	0.16***

***p< 0.001, **p< 0.01, *p< 0.05

5.2 Antecedents on project success

The associations between the dependent project success variable and the independent variables were tested with stepwise linear regression analyses. The linear regression model included four steps. First two models with control variables and SME background factors were significant but weak for their explanatory power (R2 < 0.10). The third and fourth models with project barrier and project benefit variables were significant with good explanatory power (R2 > 0.25). The model was suitable for the sample. All the variables were tested for collinearity. The base models functioned well with no multicollinearity problems (VIF values were below 1.95, refer to Appendix B). The regression analysis results are presented in the following Table 20.

Table 20. *Regression analysis results for the dependent variable project success*

	Model 1		Model 2		Model 3		Model 4	
	Beta	t	Beta	t	Beta	t	Beta	t
(Constant)		18.74***		10.47***		13.43***		2.14*
Number of staff in company	0.09	2.32*	0.05	1.30	0.06	1.74	0.10	3.48***
Staff in R&D	0.16	4.01***	0.10	2.63**	0.09	2.64**	0.11	3.76***
project FP7	-0.12	-2.52*	-0.13	-2.90**	-0.09	-2.21*	-0.14	-3.89***
project Eurostars	0.01	0.29	-0.01	-0.27	-0.02	-0.39	-0.01	-0.22
SME Experience			0.14	3.34***	0.10	2.67**	0.06	1.917
SME Limited Resources			-0.15	-3.78***	-0.07	-1.87	-0.07	-2.20*
SME Applying External Knowledge			0.04	1.01	0.02	0.72	0.01	0.29
SME Low Funding Availability			-0.02	-0.59	-0.03	-0.90	-0.03	-1.10
Barrier Administration					-0.12	-2.98**	-0.03	-0.97
Barrier Project Scale and Inefficiency					-0.21	-4.64***	-0.10	-2.71**
Barrier Irrelevance					-0.27	-6.71***	-0.16	-4.41***
Barrier Knowledge					0.11	2.94**	0.02	0.65
Barrier IPR					0.07	1.80	0.05	1.67
Barrier Money					0.03	0.73	0.02	0.65
Benefit Knowledge Transfer							0.35	8.89***
Benefit Networking							0.15	4.09***
Benefit Brand							0.12	3.60***
Benefit Cost and Risk							-0.05	-1.63
R2		0.05		0.10		0.27		0.48
Adjusted R2		0.04		0.09		0.26		0.48
F		7.85***		9.39***		17.47***		33.71***
F change		7.85***		10.48***		25.46***		66.28***

***p< 0.001, **p< 0.01, *p< 0.05

The first model with only the control variables is significant but explains only 4% of variance in the dependent variable project success (R2 = 0.04, F = 7.85, p < 0.001). In this model the respondents with higher R&D intensity have higher significant association with project success (beta = 0.16, p < 0.001). Number of staff of the respondents is also associated with project success (beta 0.09, p < 0.05) indicating that bigger SMEs experienced more success in the projects. Considering the project type, experiences in FP7 show negative association with project success (beta -0.12, p < 0.05). There is no association between experiences in Eurostars and project success.

The second model explains 9% of the variance in project success variable ($R2 = 0.09$, $F = 9.39$, $p < 0.001$). The explanatory power is still weak. The variables regarding to SME background factors were added into the model. Concerning the added SME background variables, the model shows significant association between perceived previous experience and project success (beta 0.14, $p < 0.001$), and negative association between experiencing limited resources and project success (beta -0.15, $p < 0.001$). Experiences of applying external knowledge and low availability of funding are not associated with project success. Unlike in the first model, the number of staff is not associated with project success in Model 2. The association between respondents' R&D intensity and project success weakens (beta 0.10, $p < 0.01$).

The third model with project barriers added has a good explanatory power and explains 26% of the project success variable variance ($R2 = 0.26$, $F = 17.47$, $p < 0.001$). Experiences of the respondents regarding to three barriers: administration barriers (beta -0.12, $p < 0.01$), project scale and inefficiency barriers (beta -0.21, $p < 0.001$), and irrelevance barriers (beta -0.27, $p < 0.001$) are all significantly and negatively associated with project success. Especially the experiences with barriers related to project scale and irrelevancy show significant and strong negative associations with project outcomes in this model. According to the third model, experiencing knowledge barriers is positively and significantly related with project success (beta 0.11, $p < 0.01$), meaning that the experienced lack of knowledge in R&D collaboration and expertise to contribute towards the project goals and lack of preparation may even have positive impact on project outcomes. This is an interesting finding considering the supposed negative association. Experiencing barriers regarding to shared intellectual property do not show association with project success. Experienced money barriers also do not show association with project success. Bringing the barriers into the model, the association between experienced limited resources and project success became insignificant.

The fourth model adds project benefit variables to the model. The fourth model is highly significant and explains 48% of the variance in project success variable ($R2 = 0.48$, $F = 33.71$, $p < 0.001$). This model has the highest explanatory power and therefore is used for the hypothesis testing. Respondent experiences in three of the benefits show positive and very significant association with project success. These include knowledge transfer benefits (beta 0.35, $p < 0.001$), networking experience benefits (beta 0.15, $p < 0.001$) and brand benefits (beta 0.12, $p < 0.001$), supporting H7a, H7b and H8. According to the fourth model, experiences of knowledge transfer have the strongest effect on the project success variance. Experienced cost and risk benefits did not have an association with project success, supporting H6.

Experienced irrelevance remained the strongest barrier followed by experienced project scale and inefficiency. Comparing with the third model, it is evident that the effect of perceived barriers becomes lower when bringing the benefits in the fourth model. The

benefits mediate the influence that the perceived barriers have on the project outcomes. Particularly, the mediating effect of experienced benefits outweighs completely the negative association of experienced administration barriers, consequently not supporting H1a. The mediating effect also reduces the influence of experienced project scale and inefficiency barriers (beta -0.10, $p < 0.01$) and perceived irrelevance barriers (beta -0.16, $p < 0.001$). Yet, the associations of experienced barriers related to project scale and experienced barriers related to irrelevance remain significant and negative, supporting the hypotheses H2 and H15. The positive association of experienced knowledge barriers was also outweighed, while also the experienced intellectual property barriers still show no association with project success. Therefore, hypotheses H1b and H5 are not supported. Experienced money barriers still show no association with project success in model 4, hence not supporting H3.

Unlike in the previous model, the fourth model shows negative association between perceived limited resources and project success (beta -0.07, $p < 0.05$), supporting H13. The association between perceived previous experience and project success was outweighed in the final model, not supporting H12. Consistent with the previous models, the fourth model shows no significant association between project success and experiences regarding to applying external knowledge and low availability of funding, hence the hypothesis for applying external knowledge (H14) is not supported and the hypothesis for low availability of funding (H16) is supported. Inconsistent with the third model, number of staff in company has a significant association with project success (beta 0.10, $p < 0.001$). Number of staff in company and R&D intensity (beta 0.11, $p < 0.001$) both show positive and significant association with project success, supporting H10 and H11. Consistent with the previous models, FP7 shows a negative and this time also very significant association with project success (beta -0.14, $p < 0.001$). The last model, in line with the previous models, shows that Eurostars projects are not significantly associated with project success.

5.3 Benefits as mediating factors

Bringing the benefits into the fourth model, the associations of four variables changed: 1) number of staff became positively associated with project success, 2) perceived SME previous experience was not associated with project success, 3) the significant association between experienced administration barriers and project success was outweighed, and 4) perceived knowledge barriers were not associated with project success. These changes show that the perceived benefit variables mediate the associations that the mentioned four variables have with project success. Further linear regression analyses were conducted to explain the mediating role of the project benefit variables (Appendix C). Perceived project benefits (Knowledge transfer, Networking experience, Brand benefits, and Cost and risk benefits) were tested one by one as the dependent variable in these linear regression analyses.

For each of the experienced benefit variables, the independent variables were added in three phases following the logic of the initial regression analysis: first adding the control factors, then the SME background variables, and finally the project barrier variables. There were no problems with multicollinearity (VIF values were below 1.8) The explanatory power for all the first and second models was weak (R2 < 0.04). The third models including the project barriers were significant with good explanatory power for knowledge transfer benefits (R2 = 0.17, F = 10.73, p < 0.001), brand benefits (R2 = 0.14, F = 8.71, p < 0.001), and networking experience benefits (R2 = 0.10, F = 6.50, p < 0.001). The explanatory power was weak for cost and risk benefits (R2 = 0.06, F = 3.89. p < 0.001) and therefore cost and risk benefits are not included into further analyses concerning benefits as mediating factors.

The regression analyses were used to determine the mediating effect of the experienced benefit variables for the mentioned four variables. The following Figure 4 shows the findings for company size variable.

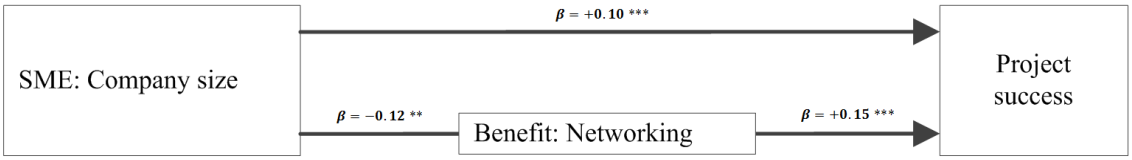

Figure 4. *The mediating variable for company size*

Number of staff became positively associated with project success when experienced networking benefit variable was added into the model. According to the results, respondents with bigger company size were more successful in terms of project success. However, company size is negatively and significantly associated with perceived network experience benefits (beta -0.12, p < 0.01). Smaller SMEs perceived generally more network experience benefits which are positively associated with project success. The following Figure 5 shows the findings for mediators of SME previous experience variable.

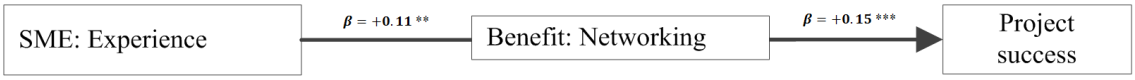

Figure 5. *The mediating variable for SME previous experience*

Perceived SME previous experience is not directly associated with project success. The findings show that perceived SME previous experience is positively and significantly associated with network experience benefits (beta 0.11, p < 0.01). Network benefits variable is therefore a mediator between SME previous experience and project success. The following Figure 6 shows the mediators for administration barrier variable.

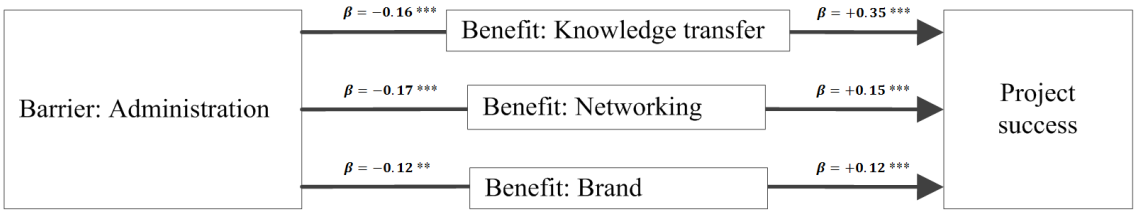

Figure 6. *The mediating variables for administration barriers*

The significant association between perceived administration barriers and project success was outweighed in the fourth model. The additional regression analyses for experienced project benefits show that the association between experienced administration barriers and project success is mediated by three experienced benefits: knowledge transfer (beta -0.16, $p < 0.001$), networking experience (beta -0.17, $p < 0.001$), and brand benefits (beta -0.12, $p < 0.01$). The respondents with successful administration experiences (administration barrier is a negative variable) generally experienced more knowledge transfer benefits, network experience benefits and brand benefits which mediate the relationship between administration barriers and project success. The following Figure 7 shows the mediating variables for knowledge barrier variable.

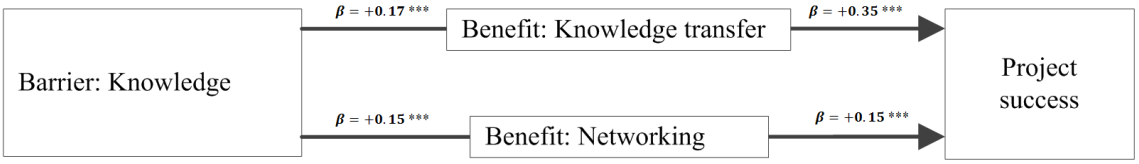

Figure 7. *The mediating variables for knowledge barriers*

In the fourth model, perceived knowledge barriers were not associated with project success. Separate linear regression analyses for perceived project benefits show that the association between knowledge barrier variable and project success is mediated with two experienced benefits: knowledge transfer benefits (beta 0.17, $p < 0.001$) and network experience benefits (beta 0.15, $p < 0.001$). The respondents who perceived knowledge barriers generally experienced more knowledge transfer and network experience benefits. However, experiencing knowledge barriers is not directly associated with project success.

5.4 Summary of the hypothesis testing results

This subchapter provides the summary of the hypothesis testing results of the linear regression analyses in the subchapter 5.2. The results are based on the fourth linear regression model with the highest explanatory power, explaining 48% of the variance in project success variable. The results are provided in the following Table 12.

Table 21. *Results of the hypothesis testing on project success*

Hypothesis		*Project Success*	*Result*
H1a	*Administration Barriers*	*negatively associated*	*Rejected*
H1b	*Knowledge Barriers*	*negatively associated*	*Rejected*
H2	*Irrelevance Barriers*	*negatively associated*	*Supported*
H3	*Financial Barriers*	*negatively associated*	*Rejected*
H5	*IPR Barriers*	*negatively associated*	*Rejected*
H6	*Cost and Risk Benefits*	*not associated*	*Supported*
H7a	*Networking Benefits*	*positively associated*	*Supported*
H7b	*Brand Benefits*	*positively associated*	*Supported*
H8	*Knowledge and resource Benefits*	*positively associated*	*Supported*
H10	*SME Size of the firm*	*positively associated*	*Supported*
H11	*SME R&D intensity*	*positively associated*	*Supported*
H12	*SME previous experience*	*positively associated*	*Rejected*
H13	*SME limited resources*	*negatively associated*	*Supported*
H14	*SME applying external knowledge*	*positively associated*	*Rejected*
H15	*Project Scale and Inefficiency Barriers*	*negatively associated*	*Supported*
H16	*Low availability of funding*	*not associated*	*Supported*

Table 21 shows that many hypotheses regarding to experienced barriers were rejected. These include administration barriers (H1a), knowledge barriers (H1b), financial barriers (H3) and intellectual property barriers (H5). Interestingly, the third model classified experiencing knowledge barriers beneficial for project success. However, it turned out that knowledge transfer benefits and network experience benefits were mediators in this association. Only the barriers related to experienced project scale and inefficiency (H15) and irrelevance (H2) were supported.

Hypotheses of benefits were all supported. Knowledge and resource benefits (H8) showed the strongest and very significant positive impact on project success. Adding benefits into the fourth model outweighed completely the negative association of administration barriers and reduced the influence of project scale and inefficiency barriers. Many of the experienced benefits acted as mediators in the associations between barriers and project success.

The respondents also experienced on average more benefits than barriers with the projects (Table 19). Experienced cost and risk benefits and the experience regarding to the availability of funding were not associated with project success. However, perceived limited resources seem to associate negatively on project success. The association between experiences of applying external knowledge and project success was rejected by all the models. The association of perceiving to have previous experience was supported by the third model, and further analyses showed the association was mediated by network experience benefits. The positive influences of firm size and R&D intensity to project success were both supported. However, smaller SMEs experienced generally more networking benefits.

All the variables included in the linear regression analyses did not have multicollinearity problems. Possible slight non-linear correlations can have a little impact on the validity of the results. The variables were mostly normal distributed. The model was theory based and suitable for the sample with a high F-value. The validity of the model seems reasonably good in terms of the statistical analyses. Also combining the subjective and relatively more objective measures can be believed to improve the validity of the answers. However, as revealed by Flor and Oltra (2004), there can be an over-assessment bias towards positive outcomes of the projects. The sample had a majority of SMEs which had participated in FP7 projects, and therefore the results may not be generalized for Eureka and Eurostars projects.

6. DISCUSSION

The purpose of this study was to explain the factors affecting project success for SMEs in international R&D collaboration projects funded by European Commission and related sources. The survey was sent to SMEs which had previously participated in 7th Framework Programme, Eureka and Eurostars funding programmes. The final sample consisted of 711 SMEs. Based on literature, the study initially identified 13 hypotheses which were further updated to the final amount of 16 after the changes in variable structures suggested by exploratory factor analyses. The project success variable includes shorter time for innovations, new or improved products, new recruitment, higher sales from market novelties, improved R&D and human capital, and encouraged more fundamental R&D. The results of this study are shown in the following Figure 8.

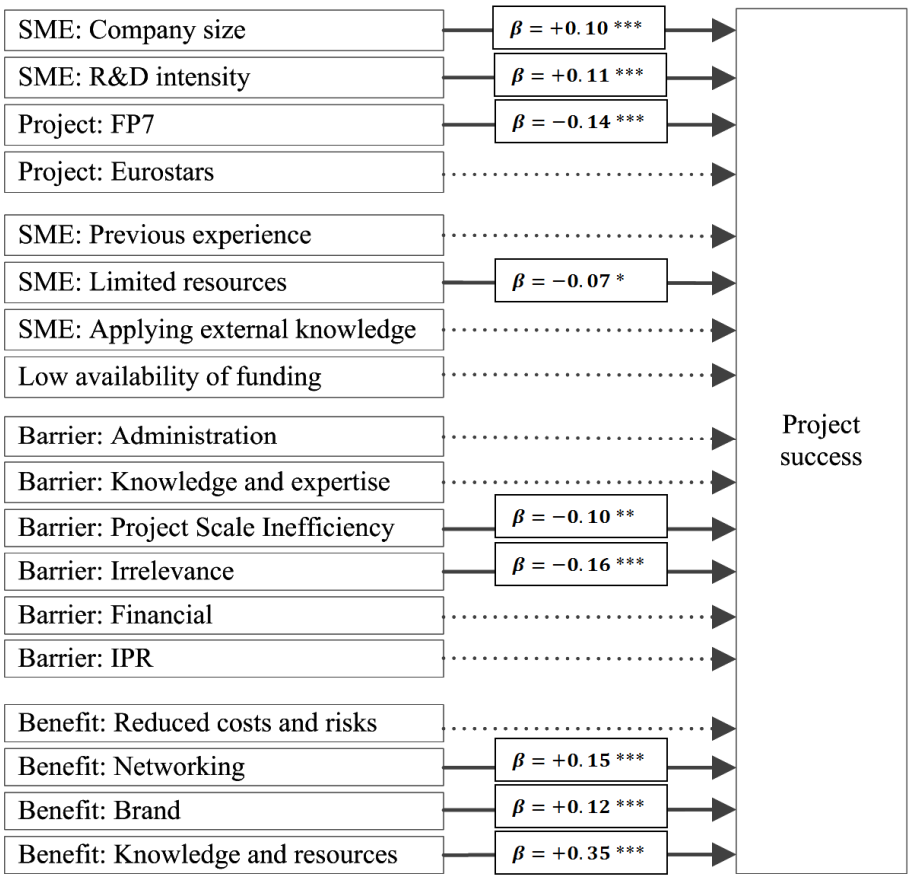

Figure 8. *The results of the study*

The results in Figure 8 are indicated based on the fourth regression model with the highest level of explained variance (48%) of the dependent project success variable.

This model was statistically very significant (for the other models refer to subchapter 5.2). The results show that company size, R&D intensity, and experienced benefits of networking, for brand, and knowledge transfer are positively and significantly associated with project success. The figure shows that knowledge transfer (beta +0.35) has the strongest impact on project success variance. According to the results there are three factors hampering project success: limited resources, inefficiency and scale of the project, and irrelevance. Irrelevance to the company is the highest constraint to project success. The figure also indicates that FP7 programmes were less successful in terms of project success compared to Eureka and Eurostars programmes. There was no significant association between Eurostars and project success.

Discussion is divided into four subchapters: reviewing insights on money and resource issues, knowledge transfer and networking benefits, the direct and mediated association of barriers, and association between SME background variables (previous experience and company size) and networking experience benefits.

6.1 SMEs: insights on money and resource issues

SMEs experience low availability of funding while project success does not directly depend on issues concerning money. The findings of the study showed that cost and risk sharing benefits and financial barriers (high own share of funding in the projects, long time to receive the money, and long time before possible revenues from the projects) experienced during the project had no association with successful outcomes of the projects. Previous research has also stated that the cost and risk sharing motives were not important (Bach et al. 2014; Narula 2004), while it is said that the sources of funding are generally lacking (Gilmore et al. 2013; Mialhe et al. 2012; Radis and Božić 2009; Hoffman et al. 1998), the projects may have long time horizons and late returns (Luukkonen 1998), and there is a delay with receiving the money (Massa and Testa 2008). In this study, the answers of SMEs averaged high for experiences with low availability of funding (3.29). However, experiences with low availability of funding were also not associated with successful outcomes in the projects. Money is something SMEs need but money alone is not enough to be successful in the projects.

Instead of money, other resources matter for project success. The findings show that perceived lack of social capital, low awareness of external sources of finance, having a limited network of universities and companies, and lack of resources in terms of staff, knowledge and materials constrain successful project outcomes. Previous literature has stated that SMEs generally lack resources (Hausman 2005; Thorpe et al. 2005; Chang and Chen 2004; Narula 2004). Based on the results, SMEs experiencing limited resources (excluding money) seem to have constrained capability to attain successful project outcomes. The results also clarify that smaller company size can be a problem for successful outcomes of the publicly funded projects for SMEs, supporting the

previous findings (Herstad et al. 2014; Kang and Park 2012; Nagassi 2004; Chang and Chen 2004). SMEs often have limited capabilities in R&D compared with large companies (Hausman 2005; Thorpe et al. 2005; Narula 2004). This study shows that resources such as staff, knowledge and social capital have an important role in the publicly funded R&D projects and lacking them can be a problem for successful project outcomes.

6.2 Knowledge transfer and networking benefits

SMEs are more dependent to knowledge outside of the company than large firms and they may face more difficulty in finding partners because they have relatively less to offer for exchange. The results indicate that the experienced knowledge and resource benefits have the strongest association with project success. Knowledge and resource benefits include new exchanges of information, improved intensity of external collaboration, improved access to complementary knowledge and complementary technologies, access to academic expertise, access to special resources and infrastructures, new technology adoption opportunities, and direct access to foreign market related knowledge. The finding is in line with previous research (Bach et al. 2014; Triguero et al. 2013; Mialhe et al. 2012; Mancinelli and Mazzanti 2009; Sakakibara 1997; Narula 2004). However, this study gives more profound insight for the role of knowledge transfer by classifying it the most important factor for project success. This study therefore shows that the projects funded by European Commission and related sources have an important role in dissemination of knowledge.

Previous research has stressed the importance of sharing complementary knowledge and technologies in a diversified network of different actors. To share this knowledge, SMEs must build networks and linkages. Experiencing networking benefits was also significantly associated with project success. Networking benefits include both the enhanced capabilities in networking in general and enhanced skills to collaborate internationally. Previous literature has suggested that SMEs may have difficulty with partnering, lack experience in networking and to benefit from R&D projects (Rosenbusch et al. 2011; Kirkels & Duysters 2010; Nunes et al. 2010; Mancinelli & Mazzanti 2009; Narula 2004). Networking improves firms' capability to build new linkages (Hernan et al. 2003; Ahuja 2000). The findings are consistent with previous literature findings on the importance of networking (Kang and Park 2012; Mialhe et al. 2012; Luukkonen 2000; Luukkonen 1998).

Experienced knowledge transfer and networking benefits were important during the projects but the experienced general capability of integrating external knowledge was not associated with project success. SMEs are claimed to lack the knowledge base to absorb the required knowledge (Kirkels & Duysters 2010) and higher absorptive capacity is considered to improve innovation performance (Kang & Park 2012). The

responses showed very high average experiences for the capability of applying external knowledge (4.12). The findings do not support the association between capability of applying external knowledge and project success. Applying external knowledge is something SMEs have to do and it is not enough to reach successful project outcomes.

Brand benefits were separated from network benefits variable based on the factor models (subchapter 4.4). Experienced brand benefits also show a significant association with project success, confirming previous literature (Rosenbusch et al. 2011). This finding strengthens the idea that the brand of the funding label is recognized in the markets and the companies can gain some reputation by participating in the projects.

6.3 The direct and mediated associations of barriers

The rejection of barrier hypotheses suggests that barriers may be less relevant than suggested in the previous literature. Further regression analyses were conducted to define more insights regarding to the role of experienced barriers. This subchapter presents the findings regarding barrier variables and benefits as mediating factors. The following Figure 9 shows the most crucial findings of these analyses.

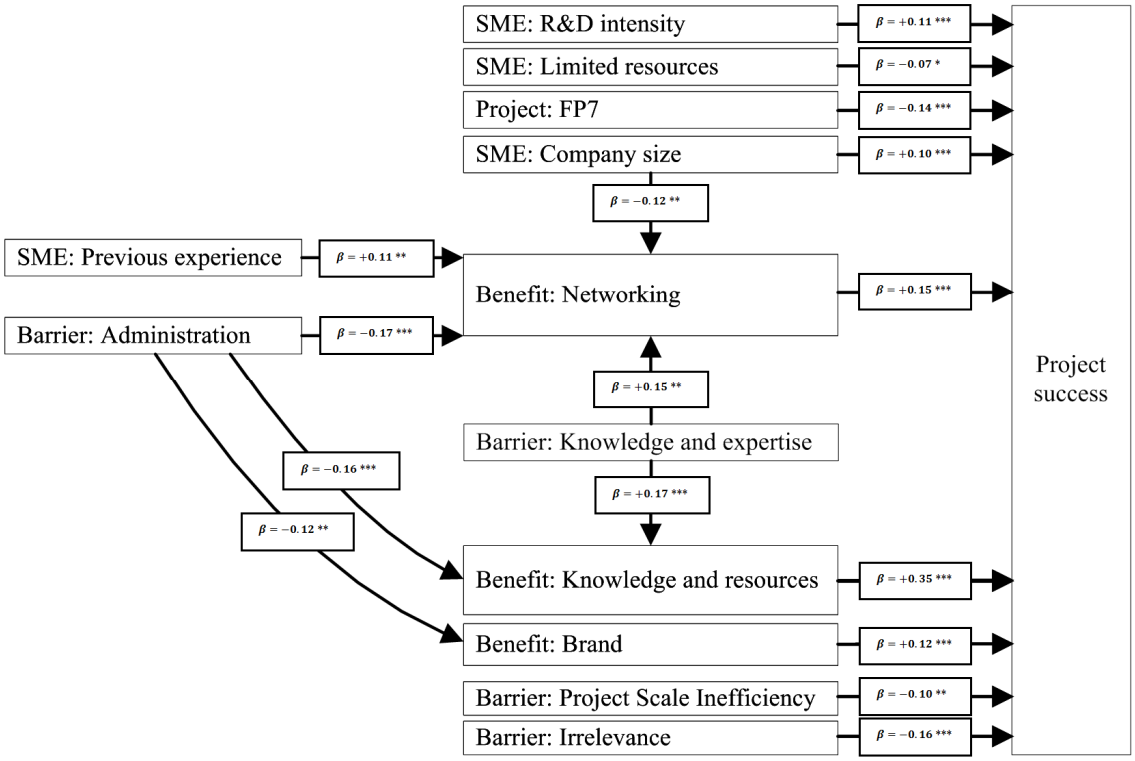

Figure 9. *Benefits as mediating variables and the role of barriers*

The statistical analyses showed that the benefits outweigh and reduce the influence of the barriers leaving only irrelevance and project scale barriers significant. The results suggest that irrelevancy of the project is harmful for the project outcomes, confirming the former research implications of irrelevancy (Bach et al. 2014; Gilmore et al. 2013;

Luukkonen 2000). Project scale and inefficiency is about an extensive project budget, partners from too many countries, inefficient collaboration and lack of market orientation (Gilmore et al. 2013; Kang & Park 2012; Defazio et al. 2009; Gilmore et al. 2006; Luukkonen 2000). The findings on project scale and inefficiency show that the projects may be too demanding for SMEs considering their size and the project scale and the general lack of resources of SMEs.

The benefits completely outweigh administration barriers. The projects are typically complex and demanding in terms of administration required (Bach et al. 2014; Gilmore et al. 2013; Massa and Testa 2008). The findings show that experienced administration barriers are not associated with project success. Although, perceived administration barriers have negative association with experienced networking benefits, knowledge and resource benefits, and brand benefits. This implies that problems with administration may lead to reduced capabilities to gain benefits with networking, knowledge transfer and enhanced brand.

Knowledge barriers (Gilmore et al. 2013; Gilmore et al. 2006) were not associated with project success. Interestingly, the results of the statistical analyses suggest that the knowledge barriers: lack of knowledge and expertise in R&D collaboration, lack of expertise and competences to contribute towards project goals, and lack of preparation have positive association with experienced knowledge transfer benefits and networking benefits. Publicly funded projects may then answer to the perceived lack of knowledge and expertise and develop the skills and expertise of SMEs.

The other two barriers related to experiences of finance and shared intellectual property were insignificant considering their association with project success. Finance barriers were discussed more in subchapter 6.1. The findings do not support the negative association between experienced intellectual property barriers and the project outcomes (Herstad et al. 2014; Kim & Vonortas 2014; Luukkonen 2000; Luukkonen 1998). Negative perceptions regarding to shared intellectual property and publicity of information did not show any connection with the success in the projects.

6.4 Previous experience and SME size: associations with networking

Literature has highlighted the importance of previous experience in the programmes (Hottenrott & Lopes-Bento 2014; Kim and Vonortas 2014). The results show no direct association between perceived previous experience and project success. Although, there was a positive and significant association between perceived previous experience and experienced networking benefits. According to previous literature, networking experience is cumulative social capital which enhances firm’s possibility to enter into new linkages (Ahuja 2000). To be successful in networking SMEs need to gain

networking experience. Perceived previous experience was not associated with experiencing the other benefits.

In general, SMEs with higher number of staff were more successful. Investigating mediating variables showed that smaller SMEs experienced more networking benefits. According to Narula (2004) small companies have more difficulties with partnering because they have relatively less to offer in exchange. If small size means higher barriers for opportunities in networking, especially small SMEs may gain more networking benefits through the projects.

7. CONCLUSIONS

This chapter presents the conclusions for the study. Summary of the study is provided in the first subchapter 7.1. Summary includes the description of the process and most important findings in the statistical analyses. After summary, the findings and conclusions for SME business development are presented in subchapter 7.2, following limitations of the study (subchapter 7.3), and ideas for future research (subchapter 7.4).

7.1 Summary

This study was particularly interested in SME business development through participation in the international R&D collaboration projects funded by European Commission and related sources. The study analysed a sample of 711 SMEs which have participated in Seventh Framework programme (2007 to 2013) and Eureka programmes including Eurostars (2004 to 2014) in about ten countries around Europe. The survey responses were collected between July and August 12, 2014 and the response rate was 9.95%. Majority of the respondents were CEOs.

The literature review indicated that SMEs typically lack resources, face problems regarding to availability of funding and they typically are more dependent on knowledge outside the company than large firms. SMEs may also face more difficulty in finding partners because they have relatively less to offer. Project success of SMEs was measured by shorter time for innovations, new or improved products, new recruitment, higher sales from market novelties, improved R&D, improved human capital, and encouraged more fundamental R&D.

The third chapter structured 13 hypotheses: These were barriers (administration, irrelevance, financial, network, intellectual property), benefits (reduced costs and risks, networking experience, new knowledge and resources), and SME background hypotheses regarding to the firms size, R&D intensity, previous experience, and the assumptions of limited resources and applying external knowledge. Exploratory factor analyses produced four new hypotheses: project scale and inefficiency, knowledge barriers, brand benefits, and low availability of funding. Network Barrier variable was discontinued. The final amount of hypotheses changed to 16.

Experienced benefits concerning knowledge and resources, networking experience and enhanced brand were found to have high significant positive association with project

success. Experienced cost and risk saving benefits, low availability of funding and the ability to integrate external knowledge were not associated with project success. The benefits also seem to mediate the effect of many of the barriers. For instance, the study found out that the experienced knowledge barriers are positively associated with experienced knowledge and resource benefits, and networking benefits.

The results suggest that only two experienced barriers associate negatively with project success: irrelevancy of the project and the barriers related to project scale. Limited resources were also significantly and negatively associated with project success. SMEs with higher R&D intensity and SMEs with higher size in terms of staff had higher probability to achieve successful project outcomes. The results show no significant relation for publicity of information and project success. The association between experienced administration barriers and project success was mediated by three benefit variables: knowledge and resources, networking and brand. The following Figure 10 shows the most significant results of the study.

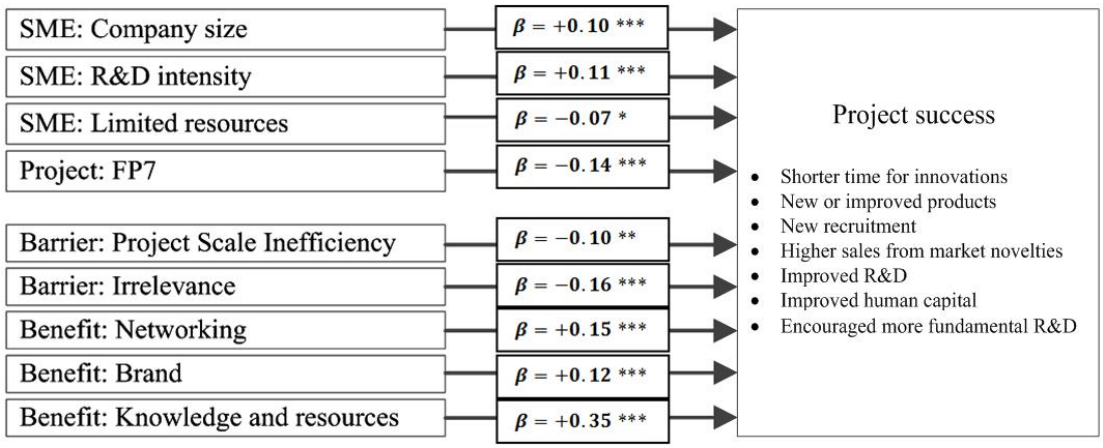

Figure 10. *The most significant results of the study*

Figure 10 includes only the variables which have the highest and significant direct impact on project success. Mediated associations are not included in the figure.

7.2 Implications for theory and practice

SME business development in EU and related international R&D collaboration projects (FP7, Eureka and Eurostars) was measured by project success criteria identified in previous research. In successful EU and related projects, SMEs can reduce their innovation time span, create new or improved products, recruit more staff, increase their sales from market novelties, improve their R&D and human capital, and also be encouraged to execute more fundamental R&D. SME business development through EU and related funding varies by project.

Projects can also lead to other outcomes, such as publications and patents. Literature has suggested using patents or patent applications as a criterion for project success. Although, patents were not consistent with the other project success criteria, confirming the findings of Massa and Testa (2008) who claim that patents are not the most reliable way to determine successful projects. After excluding patent applications, project success variable showed that in general the projects were or were not successful in all the measured areas.

Knowledge transfer was the most important factor positively associated the project success criteria. In successful projects, SMEs experienced exchanges of information, improved their intensity of external collaboration, and had an access to complementary knowledge, technologies, infrastructures, resources, and academic expertise. Successful projects included also new technology adoption opportunities and direct access to foreign market related knowledge. Previous research has widely supported the importance of knowledge transfer in publicly funded R&D projects. However, this study classifies knowledge transfer the most important factor for project success. Project participants should be encouraged to carry out more activities related to knowledge transfer to improve the success rate of the projects.

Perceived improved capabilities in networking and international collaboration during the projects were also associated with project success criteria. The findings also show that SMEs with previous experience in similar projects experienced more networking benefits. Networking benefits could be cumulative and more experience in networking leads to more networking benefits. The funding agencies generally emphasize the importance of previous experience when attributing a grant to a firm. Although, this study discovered that previous experience is not associated with project success and may mostly be important in terms of networking skills.

Findings also showed that smaller SMEs perceived more benefits concerning improved networking skills during the projects. Small SMEs are generally more constrained by their small size and have more limited opportunities to create linkages and develop their capabilities in networking. Therefore, participating in the projects can be beneficial especially for improving the networking capabilities of small SMEs.

Brand benefits were also associated with project success. This strengthens the idea that by participating in the projects, SMEs can gain some reputation and the funding label is recognized in the markets. SMEs can indeed benefit by communicating and developing their innovation orientation leading to positive perception by market participants. Rosenbusch et al. (2011) suggest that showing innovation orientation can eventually raise the brand equity of SMEs and improve their opportunities to obtain better partners and attract highly skilled labor.

Irrelevancy of the project and large project scale were the only significant project related factors negatively associated with project success criteria. Irrelevant projects have less likelihood to benefit the project participants and can potentially lead to trivial R&D. Large scale projects have an extensive project budget, partners from too many countries, inefficient collaboration and lack of market orientation. The study suggests that large scale projects can be too demanding for SMEs considering their small size and the general lack of resources. SMEs should avoid participating in irrelevant projects and projects with too extensive scale considering their resources

Administration barriers included complexity of administration of the project, required time for administration, participation requirements, lack of expertise in administration required, and limited guidance from funding agency. Administration barriers were not directly associated with project success criteria. Although, experienced barriers concerning administration had negative association with experienced networking benefits, knowledge and resource benefits, and brand benefits. Therefore, problems with administration may lead to reduced capabilities to gain benefits with networking, knowledge transfer and enhanced brand during the projects. Problems with administration could be reduced through better guidance and knowledge transfer regarding the needed administration procedures.

Knowledge barriers include lack of knowledge and expertise in R&D collaboration, lack of expertise and competences to contribute towards project goals, and lack of preparation. Experienced knowledge barriers did not have direct association with project success. Interestingly, SMEs experiencing knowledge barriers experienced more knowledge transfer benefits and networking benefits. This could mean that publicly funded projects answer to the perceived lack of knowledge and expertise and develop the skills and expertise of SMEs, also confirming that the projects have an important role in improving SMEs' expertise, competences and skills in R&D collaboration.

The findings show that SMEs generally experience low availability of funding but money does not determine whether the projects are successful. Perceived cost and risk sharing benefits had no association with project success. Experienced financial barriers (high own share of funding in the projects, long time to receive the money, and long time before possible revenues from the projects) had also no association with project success. Instead of money, other resources matter when SMEs want to be successful in the publicly funded R&D projects. Lack of social capital, low awareness of external sources of finance, limited network of universities and companies, and lack of human resources and materials constrain successful project outcomes.

The study also identified the role of several SME background factors. Small size was previously mentioned to be associated with higher level of perceived networking benefits. On contrary, smaller company size can also constrain project success. In

general, SMEs with higher R&D intensity were more successful. Perceived capability to integrate and absorb external knowledge was not associated with project success. Applying external knowledge can be considered a must for high R&D intensity SMEs. SMEs must apply external knowledge and money is something SMEs need. These two can be classified as hygiene factors without association with success in the projects.

FP7 programmes were less successful in terms of project success compared to Eureka and Eurostars programmes. However, there was no significant association between Eurostars and project success. Eureka projects are more market oriented and their financial arrangements are more diverse compared with framework programmes (Luukkonen 1998). The project success variable included new products and higher sales which might be easier to achieve with Eureka and Eurostars programmes, hence meaning negative impact of FP7 projects on project success in comparison with Eureka programmes. Although, regression analyses for mediating benefit variables show that FP7 is positively associated with perceived networking and brand benefits (refer to Appendix C).

In conclusion, the international R&D collaboration projects funded by European Commission and related sources are a good way to develop SMEs, their knowledge base, their opportunities for R&D, and their capabilities for developing new products. The most crucial implications for research and practice are the following insights:

- Knowledge transfer has the strongest impact on project success and it should be promoted by the project participants
- Previous experience is mainly important to be successful in networking
- SMEs should avoid participating in irrelevant projects and projects with too extensive scale considering their resources
- Problems with project administration constrain the chances to gain benefits with knowledge transfer, networking and enhanced brand in the projects
- SMEs with knowledge limitations experience more benefits with networking and knowledge transfer in the projects
- Money and capability to apply external knowledge were hygiene factors which are important but have no association with success in the projects

7.3 Limitations of the study

This study was based on a limited sample and SMEs were mainly from Western European countries. The sample also consisted of mostly the SMEs which had participated in FP7 programmes. It is not possible to generalize the results on any

specific countries as the results represent more the general level international outcomes and experiences in the funded projects.

The model was based on limited literature and does not explain the whole picture on publicly funded R&D collaboration. The model was also based on quantitative metrics which may exclude some important points of view. Something important might have been left out of the model. The model was created with a combination of different literature views and the supposed causal relationships were not perfectly explained in literature or used different metrics compared to the ones used in this study. The study also did not use any specific questions from previous research.

The study had a limited amount of questions and the scale was limited. For some questions, the scale should have been wider. Barrier Irrelevance and SME applying external knowledge followed normal distribution less perfectly. In both of the cases, the scale did not seem to be enough. For irrelevance barriers, the scale should had included values less than 1 on Likert-scale (1 = Strongly Disagree … 5 = Strongly Agree). SME applying external knowledge should have included possibility to answer more than 5 on Likert-scale. The frequency distributions of other variables were adequate.

The consistency of variables created in exploratory factor analyses was generally good. The four exceptions with lower Cronbach's alpha are Money barriers (0.68), SME limited resources (0.67), SME applying external knowledge (0.68), and SME low funding availability (0.64). The results concerning these variables may be less reliable. The other created variables had a Cronbach's alpha more than 0.70. Reviewing the individual plots between independent variables and dependent project success variable indicated mostly linear correlations.

Knowledge transfer variable and networking experience variable included some overlapping items. The five overlapping items were included in knowledge transfer variable mainly because of their involvement with access to external information, knowledge, and technologies. Some of the component scores for the items of knowledge transfer variable were relatively low (0.34 & 0.38). The item concerning the intensity of external collaboration was included into knowledge transfer variable instead of network experience benefit variable. These choices may have impact on some of the results.

The regression model was theory based and suitable for the sample with a high F-value. All the variables included in the linear regression analyses did not have multicollinearity problems. The model tested linear correlations between the independent variables and the dependent project success variable, excluding the analysis of more complex relationships between the variables. Possible slight non-linear correlations can have a little impact on the validity of the results. All mediating relationships were not taken

into account. For example the mediating effects of barrier variables and SME background variables were not included.

Likert-type scales make the metrics subjective and unable to gather objective data.. Subjective answers have been proven to be close to the reality in some previous research (Jennings & Young 1990; Manopichetwattana 1989). However, some research claims that there might be a tendency to overestimate the answers concerning positive outcomes (Flor and Oltra 2004). The validity of the project success variable was improved by adding both subjective measures and relatively more objective measures. Using seven different items for measuring project outcome should improve the validity of the variable in some extend.

Measuring of innovation can be based on outputs or inputs. Inputs include for example participation in R&D projects with other organizations, acceptance on publicly funded innovation support programs, and educational background of the staff (Flor and Oltra 2004). The sample included only SMEs which were accepted to the funded projects, and hence may not represent the most generic type of R&D intensive SMEs. They might have more skills since they were evaluated and accepted to the programmes and be more capable to minimize the barriers and maximize the benefits in the projects.

The reliability of the answers is affected by the memory of answering person and employee turnover. The projects of the respondents were in a time frame from 2007 to 2013 for FP7 and from 2004 to 2014 for Eureka programmes (including Eurostars). Some of the respondents claimed they had not participated into any of the programmes even though they were on the lists. It also might be that the respondent is not always the person who knows most about the project in the company. In some cases, though rarely, the questionnaire might have been sent to a wrong email address.

7.4 Ideas for future research

Future research could concentrate more specifically on the differences between the funding instruments and their impact on project success criteria. There could also be potential to compare individual countries and the differences in perceived prevalence of barriers and benefits between them.

The sample included SMEs mainly from Western Europe and for example sharing costs and risks was not important considering the project success. Future research could investigate the emerging transition economies in East Europe for example to find out whether money does not have direct influences on project success in those countries.

More research is needed to investigate the role of experienced knowledge barriers. The research could investigate if the truth is that SMEs with less knowledge can really

experience more benefits in the projects. On contrary, it might even that the companies experiencing knowledge barriers actually are the companies with more knowledge. The question could be whether experiencing knowledge barriers is associated with higher urge to develop their own capabilities or the inability to advance their skills.

The general issues concerning developing SMEs through funding programmes need also more clarification. If the role of the projects is to develop SMEs, then is it really so that the projects benefit most the SMEs which are less developed than the ones which have previously participated in the programmes many times.

Rejected in this study, the association between absorptive R&D capacity and project success may also need further research. It might be that all the SMEs in the sample had high ability to apply external knowledge. At least they were evaluated and chosen for the funding programmes. The importance of absorptive R&D capacity could be more relevant for common SMEs.

The study did not find out why SMEs in general are not interested in EU funding in comparison with national funding programmes. The results show that SMEs experience much more benefits than barriers, and therefore it might be that SMEs lack the knowledge of the possible benefits regarding to EU projects.

There might also be potential to investigate the rejected hypotheses, whether administration barriers and lack of previous experience really do not associate with project success. And is their indirect effect mediated by benefits tolerable or not.

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APPENDIX A: QUESTIONNAIRE FORM

1. Company background information

Please provide background information of your company which has participated in collaborative R&D projects funded by EC and related sources

Current business sector:

- ○ Electronics, IT and telecoms technology
- ○ Industrial manufacturing, material and transport
- ○ Other industrial technologies
- ○ Energy technology
- ○ Chemistry, physical and exact sciences
- ○ Biological and medical sciences
- ○ Other, which?

- ○ Agriculture and marine resources
- ○ Agrofood technology
- ○ Measurements and strandards
- ○ Technology for protecting man and the environment
- ○ Management Consulting

Company type:

- ○ SME (less than 250 employees)
- ○ Other, which?

- ○ Big company

Number of staff in company:

- ○ 0-9
- ○ 10-49
- ○ 50-249
- ○ 250-

Staff in R&D (2013)

Main role of the answering person:

- ○ CEO, Chief Executive Officer/Managing Director
- ○ CEO & Owner
- ○ Owner
- ○ CFO, Chief Financial Officer
- ○ COO, Chief Operating Officer
- ○ CTO, Chief Technology Officer
- ○ Other, which?

- ○ Chairman of board
- ○ Marketing director
- ○ head of R&D
- ○ Project manager
- ○ secretary

Country of the company/unit:

Which of the following has your company participated or is participating as beneficiary or/and associated partner?

	Yes, once	Yes, more than once	No	Don't know
7th Framework programme (FP7)	○	○	○	○
Eurostars	○	○	○	○
Eureka (many instruments, excluding Eurostars)	○	○	○	○
Horizon 2020	○	○	○	○
National funding programmes	○	○	○	○

Others, which?

The most recent project participation (among FP7, Eureka or Eurostars)

The company's business is mainly based on academic research (i.e. academic spin off)

- ○ Yes
- ○ No
- ○ Don't know

1 / 5 20%

2. Company background information

Do you agree or disagree following statements related to your company?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
The company has a high ability to integrate external knowledge	○	○	○	○	○	○
The company constantly applies external knowledge in R&D	○	○	○	○	○	○
We have low bureaucracy inside the company	○	○	○	○	○	○
We have a limited external network of universities and companies	○	○	○	○	○	○
The company lacks experience in networking (with universities, other companies etc)	○	○	○	○	○	○
The company lacks awareness to external sources of finance	○	○	○	○	○	○
The company lacks resources (staff, materials, knowledge, etc)	○	○	○	○	○	○

Prior to the most recent FP7, Eureka or Eurostars participation your company had:

	Never	Rarely	Sometimes	Often	Very often	Don't know
previously participated in national funding programmes	○	○	○	○	○	○
earlier R&D collaboration with external companies/universities	○	○	○	○	○	○
acted as a lead partner/coordinator in collaborative R&D project	○	○	○	○	○	○
previous experience in the administration of a similar project	○	○	○	○	○	○

Was your company's most recent FP7, Eureka or Eurostars project gathered from already known relationships (with companies and universities)?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
Collaboration in the project was based on former links/relationships	○	○	○	○	○	○

What is the availability of funding in your country?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
There is low availability of suitable national public funding in the country where the company is registered	○	○	○	○	○	○
There is low availability of external private funding in the country where the company is registered	○	○	○	○	○	○

3. Experience in the most recent project: FP7, Eureka or Eurostars

Base your answers on your most recent experience in FP7, Eureka or Eurostars project in which your company has participated. If your company participated in more than one project, please answer according to THE MOST RECENT PROJECT. Do you disagree or agree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
Given the project targeted outcome (technology, product etc.), it was important to share development costs with the other participants	○	○	○	○	○	○
Given the project targeted outcome (technology, product etc.), it was important to share risks with the other participants	○	○	○	○	○	○
The project helped to access other sources of funding	○	○	○	○	○	○
The project improved capabilities in networking	○	○	○	○	○	○
The project enhanced skills to collaborate internationally	○	○	○	○	○	○
In general, international partnerships are more important than domestic ones	○	○	○	○	○	○
The project enhanced our brand and/or visibility	○	○	○	○	○	○
The project enhanced our credibility	○	○	○	○	○	○

Do you disagree or agree with the following statements (answer according to THE MOST RECENT project)?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
The project allowed new exchanges of information, otherwise deemed impossible to achieve	○	○	○	○	○	○
The project improved the company's overall intensity of external collaboration	○	○	○	○	○	○
The project improved the company's access to complementary knowledge	○	○	○	○	○	○
The project enhanced access to complementary technologies	○	○	○	○	○	○
The project improved access to pertinent academic expertise	○	○	○	○	○	○
The project brought up new technology adoption opportunities	○	○	○	○	○	○
The project allowed direct access to foreign market related knowledge	○	○	○	○	○	○
The project enhanced access to special resources and infrastructures, important for the company	○	○	○	○	○	○
The project allowed staff exchange and staff secondments (to partner firms, universities, etc)	○	○	○	○	○	○
The project partners were represented from multiple industry sectors	○	○	○	○	○	○

4. Experience in the most recent project: FP7, Eureka or Eurostars

Experience in FP7, Eureka and Eurostars projects:

Base your answers on your most recent experience in FP7, Eureka or Eurostars project in which your company has participated. If your company participated in more than one project, please answer according to THE MOST RECENT PROJECT. Do you disagree or agree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
During the project the company lacked expertise and competences to fully contribute towards the project goals	○	○	○	○	○	○
The company lacked knowledge and experience in R&D collaborations to fully contribute towards the project goals	○	○	○	○	○	○
In general, the company and its personnel should have been more prepared before the start of the project	○	○	○	○	○	○
The company had limited guidance and information from funding agency during the project	○	○	○	○	○	○
The co-operation between partners was ineffective during the project	○	○	○	○	○	○
The project administration required too much time	○	○	○	○	○	○
The company lacked expertise in the administration required	○	○	○	○	○	○
The project's administration was too complex	○	○	○	○	○	○
The funding agency participation requirements lower the motivation to take part in projects	○	○	○	○	○	○

Do you disagree or agree with the following statements (answer according to THE MOST RECENT project)?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
The project was irrelevant to the company's objectives	○	○	○	○	○	○
The strategic importance of the project was low to our company	○	○	○	○	○	○
The project was far from the company's core competences	○	○	○	○	○	○
The project had too long time horizon to completion	○	○	○	○	○	○
The time to receive money from the funding agency/agencies was too long	○	○	○	○	○	○
The company's own share of funding was too high in the project	○	○	○	○	○	○
The project had too long time before possible revenues based on the project	○	○	○	○	○	○
The project lacked market orientation	○	○	○	○	○	○
The project was too ambitious from technological perspective	○	○	○	○	○	○
The project budget was too extensive, results could be reached with smaller budget	○	○	○	○	○	○
The project had partners from too many countries	○	○	○	○	○	○
The joint IPR ownership scheme in the project was/is harmful for the company's business in the long run	○	○	○	○	○	○
Opening up the project results and documentation to public domain was/is harmful to our company	○	○	○	○	○	○

5. Outcomes in the most recent project: FP7, Eureka or Eurostars

Base your answers on your most recent experience in FP7, Eureka or Eurostars project in which your company has participated. If your company participated in more than one project, please answer according to THE MOST RECENT project. Do you disagree or agree with the following statements?

To what extent were the following outcomes reached?

	Not at all	Little	Somewhat	Much	A Great Deal	Don't know
Shorter time for innovations	○	○	○	○	○	○
New or improved products	○	○	○	○	○	○
New recruitment	○	○	○	○	○	○
Higher sales from market novelties	○	○	○	○	○	○
Patent applications	○	○	○	○	○	○
Improved R&D	○	○	○	○	○	○
Improved human capital	○	○	○	○	○	○
Encouraged more fundamental R&D	○	○	○	○	○	○

Do you disagree or agree with the following statements (answer according to THE MOST RECENT project)?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
The project would not have been carried out without the FP7, Eureka or Eurostars programmes	○	○	○	○	○	○
The network continued to operate after the project	○	○	○	○	○	○

How do you think the funding instruments (FP7, Eureka, Eurostars) match your needs and how would you improve them?

Any comments related to this questionnaire?

What were the initial reasons for participating in FP7, Eureka or Eurostars? If your company participated in more than one project, please answer according to THE MOST RECENT project.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't know
The consortium asked us to participate	○	○	○	○	○	○
The project did fit into our business strategy	○	○	○	○	○	○
The consortium included potential customers	○	○	○	○	○	○
We needed more resources for developing new products and the business	○	○	○	○	○	○
The money (grant) was the main reason	○	○	○	○	○	○
The label (eg. Eureka label) was the main reason	○	○	○	○	○	○
We wanted to have more experience in international projects	○	○	○	○	○	○
We believed it was a good way to access new markets	○	○	○	○	○	○
We believed it was good for our brand and credibility	○	○	○	○	○	○

Other reasons?

In case you would like to receive the results of the survey, you can provide your email address

I would like to receive the survey results

○ No

○ Yes, please send to the following email

5 / 5 100%

APPENDIX B: LINEAR REGRESSION COEFFICIENTS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	2.668	0.142	.	18.741	0.000		
	Number of staff in company	0.101	0.043	0.090	2.315	0.021	0.952	1.051
	Staff in R&D	0.101	0.025	0.155	4.014	0.000	0.960	1.042
	project FP7	-0.220	0.087	-0.119	-2.521	0.012	0.646	1.549
	project Eurostars	0.037	0.125	0.014	0.294	0.769	0.649	1.541
2	(Constant)	2.848	0.272		10.475	0.000		
	Number of staff in company	0.057	0.044	0.051	1.302	0.193	0.896	1.116
	Staff in R&D	0.067	0.026	0.103	2.629	0.009	0.885	1.130
	project FP7	-0.249	0.086	-0.134	-2.898	0.004	0.630	1.588
	project Eurostars	-0.033	0.122	-0.012	-0.268	0.789	0.639	1.565
	SME Experience	0.113	0.034	0.136	3.341	0.001	0.815	1.227
	SME Limited Resources	-0.155	0.041	-0.152	-3.785	0.000	0.839	1.191
	SME Applying External Knowledge	0.040	0.040	0.038	1.005	0.315	0.942	1.061
	SME Funding Availability	-0.020	0.033	-0.022	-0.593	0.554	0.941	1.063
3	(Constant)	3.695	0.275		13.433	0.000		
	Number of staff in company	0.069	0.040	0.062	1.745	0.082	0.885	1.130
	Staff in R&D	0.062	0.023	0.095	2.644	0.008	0.862	1.160
	project FP7	-0.174	0.079	-0.094	-2.206	0.028	0.608	1.645
	project Eurostars	-0.044	0.111	-0.016	-0.394	0.694	0.635	1.575
	SME Experience	0.082	0.031	0.099	2.674	0.008	0.807	1.239
	SME LimitedResources	-0.075	0.040	-0.073	-1.872	0.062	0.729	1.372
	SME Applying External Knowledge	0.026	0.036	0.025	0.719	0.472	0.925	1.082
	SME Funding Availability	-0.027	0.030	-0.031	-0.904	0.366	0.918	1.090
	Barrier Administration	-0.112	0.038	-0.123	-2.984	0.003	0.655	1.528
	Barrier Project Scale and Inefficiency	-0.228	0.049	-0.206	-4.637	0.000	0.564	1.773
	Barrier Irrelevance	-0.298	0.044	-0.273	-6.710	0.000	0.671	1.491
	Barrier Knowledge	0.114	0.039	0.114	2.939	0.003	0.737	1.356
	Barrier IPR	0.061	0.034	0,065	1.804	0.072	0.853	1.172
	Barrier Money	0.028	0.038	0.029	0.726	0.468	0.703	1.422
4	(Constant)	0.656	0.306		2.142	0.033		
	Number of staff in company	0.118	0.034	0.105	3.480	0.001	0.873	1.146
	Staff in R&D	0.075	0.020	0.115	3.756	0.000	0.849	1.177
	project FP7	-0.264	0.068	-0.143	-3.894	0.000	0.592	1.689
	project Eurostars	-0.021	0.094	-0.008	-0.222	0.824	0.633	1.581
	SME Experience	0.050	0.026	0.061	1.917	0.056	0.797	1.255
	SME Limited Resources	-0.075	0.034	-0.073	-2.203	0.028	0.723	1.383
	SME Applying External Knowledge	0.009	0.031	0.009	0.292	0.770	0.916	1.092
	SME Funding Availability	-0.028	0.026	-0.032	-1.098	0.272	0.914	1.094
	Barrier Administration	-0.031	0.032	-0.034	-0.966	0.335	0.637	1.569
	Barrier Project Scale and Inefficiency	-0.115	0.042	-0.103	-2.706	0.007	0.544	1.840
	Barrier Irrelevance	-0.171	0.039	-0.157	-4.411	0.000	0.628	1.592
	Barrier Knowledge	0.022	0.033	0.022	0.647	0.518	0.711	1.407
	Barrier IPR	0.048	0.029	0.051	1.672	0.095	0.843	1.186
	Barrier Money	0.021	0.032	0.022	0.646	0.519	0.700	1.429
	Benefit Knowledge Transfer	0.475	0.053	0.349	8.888	0.000	0.515	1.943
	Benefit Networking	0.155	0.038	0.148	4.087	0.000	0.603	1.659
	Benefit Brand	0.134	0.037	0.125	3.605	0.000	0.664	1.507
	Benefit Cost and Risk	-0.046	0.028	-0.050	-1.628	0.104	0.840	1.191

a. Dependent Variable: Project_Success

APPENDIX C: REGRESSION ANALYSES FOR BENEFIT VARIABLES

This appendix shows the regression analyses for the benefit variables: Knowledge transfer, Networking experience, Brand benefits, and Cost and risk benefits. Benefits were tested as dependent variables to explain their role as mediating factors between the other variables and the project success variable.

Dependent variable: Knowledge transfer

	Model 1		Model 2		Model 3	
	Beta	t	Beta	t	Beta	t
(Constant)		34.77***		16.84***		19.07***
Number of staff in company	-0.04	-1.08	-0.07	-1.62	-0.06	-1.61
Staff in R&D	-0.04	-0.94	-0.07	-1.80	-0.07	-1.90
project FP7	0.01	0.18	0.00	0.09	0.05	1.20
project Eurostars	0.02	0.50	0.01	0.25	0.01	0.20
SME Experience			0.09	2.13*	0.05	1.41
SME Limited Resources			-0.04	-1.05	0.02	0.57
SME Applying External Knowledge			0.06	1.53	0.05	1.46
SME Low Funding Availability			0.01	0.32	0.01	0.33
Barrier Administration					-0.16	-3.68***
Barrier Project Scale and Inefficiency					-0.23	-4.93***
Barrier Irrelevance					-0.22	-5.06***
Barrier Knowledge					0.17	4.13***
Barrier IPR					0.06	1.60
Barrier Money					0.02	0.51
R2		0.00		0.02		0.18
Adjusted R2		-0.00		0.01		0.17
F		0.51		1.68		10.73***
F change		0.51		2.85*		22.37***

***p< 0.001, **p< 0.01, *p< 0.05

Dependent variable: Networking experience

	Model 1		Model 2		Model 3	
	Beta	t	Beta	t	Beta	t
(Constant)		29.19***		15.12***		15.70***
Number of staff in company	-0.08	-2.03*	-0.11	-2.80**	-0.12	-3.06**
Staff in R&D	-0.01	-0.33	-0.04	-1.04	-0.04	-0.91
project FP7	0.11	2.34*	0.11	2.40*	0.15	3.28**
project Eurostars	-0.05	-1.01	-0.05	-1.16	-0.05	-1.08
SME Experience			0.13	3.18**	0.11	2.78**
SME Limited Resources			-0.04	-1.04	0.00	-0.09
SME Applying External Knowledge			-0.02	-0.51	-0.02	-0.56
SME Low Funding Availability			-0.02	-0.39	0.00	0.00
Barrier Administration					-0.17	-3.74***
Barrier Project Scale and Inefficiency					-0.10	-1.98*
Barrier Irrelevance					-0.10	-2.30*
Barrier Knowledge					0.15	3.64***
Barrier IPR					-0.01	-0.30
Barrier Money					-0.02	-0.40
R2		0.03		0.05		0.12
Adjusted R2		0.02		0.04		0.10
F		4.96***		4.40***		6.50***
F change		4.96***		3.75**		8.89***

***p< 0.001, **p< 0.01, *p< 0.05

Dependent variable: Brand benefits

	Model 1		Model 2		Model 3	
	Beta	t	Beta	t	Beta	t
(Constant)		27.58***		13.66***		15.87***
Number of staff in company	-0.04	-0.97	-0.06	-1.52	-0.05	-1.33
Staff in R&D	0.09	2.36*	0.05	1.35	0.04	1.09
project FP7	0.09	1.99*	0.09	1.79	0.11	2.50*
project Eurostars	-0.01	-0.18	-0.02	-0.52	-0.02	-0.48
SME Experience			0.08	1.97*	0.06	1.42
SME Limited Resources			-0.07	-1.80	0.00	0.02
SME Applying External Knowledge			0.06	1.48	0.04	1.00
SME Low Funding Availability			0.01	0.16	0.00	0.12
Barrier Administration					-0.12	-2.71**
Barrier Project Scale and Inefficiency					-0.11	-2.29*
Barrier Irrelevance					-0.24	-5.56***
Barrier Knowledge					0.07	1.62
Barrier IPR					-0.04	-1.13
Barrier Money					0.04	0.99
R2		0.02		0.04		0.16
Adjusted R2		0.02		0.03		0.14
F		3.79**		3.68***		8.71***
F change		3.79**		3.50**		14.83***

***p< 0.001, **p< 0.01, *p< 0.05

Dependent variable: Cost and risk benefits

	Model 1		Model 2		Model 3	
	Beta	t	Beta	t	Beta	t
(Constant)		24.12***		10.05***		11.13***
Number of staff in company	-0.01	-0.13	-0.02	-0.47	-0.01	-0.21
Staff in R&D	-0.03	-0.81	-0.06	-1.53	-0.08	-1.94
project FP7	0.11	2.34*	0.12	2.49*	0.13	2.80**
project Eurostars	0.02	0.50	0.02	0.51	0.02	0.50
SME Experience			0.08	1.85	0.06	1.42
SME Limited Resources			0.03	0.66	0.09	2.17*
SME Applying External Knowledge			0.06	1.64	0.05	1.33
SME Low Funding Availability			0.06	1.57	0.06	1.44
Barrier Administration					-0.08	-1.70
Barrier Project Scale and Inefficiency					-0.10	-2.07*
Barrier Irrelevance					-0.14	-3.01**
Barrier Knowledge					-0.02	-0.54
Barrier IPR					0.00	-0.02
Barrier Money					0.05	1.18
R2		0.01		0.02		0.08
Adjusted R2		0.01		0.01		0.06
F		1.83		2.10*		3.89***
F change		1.83		2.35		6.15***

***p< 0.001, **p< 0.01, *p< 0.05