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Engaging Small and Medium Size Enterprises in European Union Funded Research and Development Projects

School of Electrical Engineering

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<p>Euroopan Unioni on strategiassaan ottanut tavoitteekseen turvata kilpailukykyä ja alueen kestävä talouskasvun ja kehityksen tulevina vuosikymmeninä. Sekä pienillä ja keskisuurilla yrityksillä että uusilla ICT-teknologioilla nähdään suuri merkitys näiden tavoitteiden toteutumisessa. Tämä heijastuu myös osana 7. puiteohjelmaa rahoitettavaan tulevaisuuden Internet-teknologioiden hyödyntämiseen tähtäävään yksityisten ja julkisten tahojen Future Internet Public Private Partnership -kumppanuusohjelmaan (FI PPP).</p> <p>Tämä työ on toteutettu osana FI PPP:tä koordinoivaa CONCORD-projektia ja pyrkii etsimään ja esittämään keinoja, joilla pienet ja keskisuuret yritykset saataisiin paremmin mukaan sekä Euroopan laajuisten puiteohjelmien, FI PPP:n että yksittäisten projektien tasolla. Tutkimus on tehty yhdistämällä kattava kirjallisuuskatsaus sekä haastattelututkimuksena toteutettu kokeellinen osuus. Kirjallisuutena on käytetty aihepiiriin akateemista kirjallisuutta sekä aiempia aihepiiristä tehtyjä selvityksiä ja raportteja. Haastatteluja tehtiin yhteensä 16 kappaletta puolistrukturoituina teemahaastatteluina. Haastateltavat asiantuntijat edustivat eri tahoja pienyrityksistä ja virkamiehistä etujärjestöihin ja tutkijoihin.</p> <p>Lopputulemana voidaan todeta, että pk-yritysten aktiivinen osallistaminen on perusteltua, mutta ei tällä hetkellä toimi hyvin. Perustavanlaatuinen ongelma piilee siinä, että toisin kuin suurilla yrityksillä, pienillä ja keskisuurilla yrityksillä ei tyypillisesti ole "ylimääräisiä" resursseja käytettäväksi yhteisiin T&K-hankkeisiin osallistumiseen, niiden valmisteluun tai mahdollisuuksien etsimiseen. Lisäksi raskaaksi arvioidut hallinnolliset vaatimukset sekä tietämättömyys osallistumismahdollisuuksista vähentävät osallistumista. Ylipäänsä pk-yritysten on vaikea arvioida osallistumisen hyödyllisyyttä.</p> <p>Haasteeseen vastaamiseksi on tässä työssä esitetty kolme uutta lähestymistapaa sekä suositeltavia toimenpiteitä EU:n, FI PPP:n ja yksittäisten projektien tasolla. Kolme lähestymistapaa kuvaavat tarvetta huomioida pk-yritysten erityistarpeet ja rajoitukset, suunnitella toimiva viestintärajapinta pk-yritysten suuntaan sekä hyödyntää arverkkosten käsitettä projekteja suunniteltaessa ja niistä viestittäessä. Vaikka muutokset EU-mittakaavassa vievät aikaa, nähdään FI PPP -ohjelmalla hyvät mahdollisuudet toteuttaa pk-yritysten osallistamista menestyksekkäästi.</p>			
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<p>The European Union has stated ensuring competitiveness and sustainable growth and development as strategic goals for the next decades. Both small and medium enterprises (SMEs) and new ICT-innovations are seen to have a significant role in reaching these goals. This is reflected also in the premises of the Future Internet Public Private Partnership (FI PPP), a collaborative R&D programme funded under 7th Framework Programme.</p> <p>This study has been conducted as a part of CONCORD project, which is responsible for the coordination of the FI PPP programme, and aims to find and present means to improve the quantity and quality of SME engagement within the Framework Programmes, FI PPP and individual projects. The study combines extensive literature review and empiric part consisting of interview research. The literature used consists of both academic sources and previous reports and investigations on the topic. The interview study consisted of 16 semi-structured thematic interviews. The interviewed experts represented different key stakeholders reaching from entrepreneurs to officials and from interest groups to researchers.</p> <p>As a conclusion it can be stated that active SME engagement is justified, but needs a lot more effort. The key challenge is that while large corporations and research institutions typically have extra resources to be devoted to collaborative R&D projects, SMEs typically lack them. Also the administrative burden is considered heavy and unawareness of opportunities decrease the interest towards EU funded R&D projects. Altogether, it is difficult for an SME to assess whether participation is beneficial or not.</p> <p>As a response to these challenges, this study presents three new approaches and recommended measures for European Union, FI PPP and individual project level. The three approaches stem from the need to acknowledge the special needs and restrictions of SME, to design interaction via communicative interface and to attract the relevant SMEs by using value network concepts to build effective and attractive projects. Although any changes on the EU scale take time, the flexibility and coordination within FI PPP give the programme good chances to succeed in SME engagement.</p>		
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Foreword

After months of work, my Master's thesis is now done. I would like to thank professor Jukka Manner for supervision and Mikko Rieppula for instruction of this study. Both of them provided encouraging, straight-to-the-point feedback that helped me in writing a solid thesis and developing in research work and writing. I would like to thank each and every one of the interviewees that devoted their precious time to answer my questions and made me understand that the topics of the study are important and the results can be both useful and meaningful. I would also like to thank my great colleagues and other folks at CKIR. Special thanks go to Daniel, Tuuli, Yu, Lasse, Iida, Juha, Atte, Jorma and Ludmila for fun and productive atmosphere and Jukka for keeping up this spirit. Although it's only my name that stands in the cover, I owe many others for their time, help and support.

...

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Kaikkein suurin kiitos kuuluu tietysti ihastuttavalle, joskin savolaiselle Karolle, wappuheilalle, joka osoittautui vaimomateriaaliksi. Kiitos innostamisesta ja tuesta tätä työtä tehdessä ja ihan kaikesta ennen sitä.

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Table of Contents

Abstract in Finnish.....	ii
Abstract.....	iii
Foreword.....	iv
Table of Contents.....	v
List of abbreviations.....	vii
1 Introduction.....	1
1.1 Research questions, objectives, structure and scope.....	1
1.2 Research methods.....	3
1.3 About the case.....	3
1.4 Results.....	5
2 Publicly funded collaborative R&D.....	6
2.1 Innovation and R&D.....	6
2.2 Role of public funding.....	7
2.3 European Union.....	9
2.3.1 Framework Programmes and FP7.....	10
2.3.2 Public-private partnerships.....	13
2.4 Finland.....	14
2.5 Other regions.....	15
2.6 Chapter summary.....	16
3 Small and medium enterprises.....	17
3.1 Entrepreneurship.....	17
3.2 SME Definitions.....	18
3.3 Significance in the economy.....	19
3.4 SME classifications.....	21
3.4.1 Classification by sector.....	21
3.4.2 Classification by growth orientation and stage.....	22
3.4.3 Classification by innovation capabilities.....	25
3.4.4 Classification by participation in R&D collaboration.....	29
3.5 Chapter summary.....	32
4 SMEs in the EU funded research and development projects.....	33
4.1 SME engagement and participation in FP7.....	33

4.1.1	Programmes outside FP7.....	34
4.2	The participation process from the SME perspective.....	35
4.3	Motives.....	38
4.4	Benefits.....	38
4.5	Barriers and needs.....	40
4.6	Other issues.....	41
4.7	Previous policy recommendations.....	41
4.8	Chapter Summary.....	45
5	Empiric study.....	46
5.1	Research methodology.....	46
5.2	Interview arrangements.....	47
5.3	Limitations.....	49
6	Results.....	51
6.1	SME engagement and collaborative R&D in general.....	51
6.2	Benefits and barriers.....	52
6.3	European and national level programmes.....	54
6.4	SME roles.....	55
6.5	Public-private partnerships.....	56
6.6	SME classification and requirements.....	56
6.7	Measuring engagement.....	58
6.8	Policy recommendations.....	59
6.9	Chapter summary.....	64
7	Synthesis and conclusions.....	65
7.1	Positive discrimination approach.....	65
7.2	Communicative interface approach.....	67
7.3	Value network approach.....	69
7.4	Recommended measures.....	70
7.5	Suggestions for further research.....	72
7.6	Conclusive summary.....	73
	References.....	74
	Appendix A: List of the Interviews.....	87
	Appendix B: Interview questions.....	88

List of abbreviations

BRICS	Brazil, Russia, India, China and South Africa
CERN	European Organization for Nuclear Research
CIP	Competitiveness and Innovation Framework Programme
COSME	Programme for the Competitiveness of enterprises and SMEs
EeB	Energy efficient Buildings Public-Private Partnership
EIT	European Institute for Technology
ERA	European Research Area
ERC	European Research Council
ESA	European Space Agency
ETP	European Technology Platform
EU	European Union
EU-15	15 first member states of the European Union
EU-12	12 latest member states of the European Union
EU-27	27 member states of the European Union
EURAB	European Research Advisory Board
Euratom	European Organization for Nuclear Research
FI-PPP	Future Internet Public Private Partnership
FoF	Factories of the Future Public-Private Partnership
FP	Framework Programmes for Research and Technological Development
FP7	Seventh Framework Programme
GBAORD	Government budget appropriations or outlays on research and development
GC	Green Cars Public-Private Partnership
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
IPR	Intellectual property rights
JTI	Joint Technology Initiative
MAPEER SME	Making Progress and Economic enhancement a Reality for SMEs -project
NACE	Statistical Classification of Economic Activities in the European Community (Nomenclature statistique des activités économiques dans la Communauté européenne)
NCP	National Contact Point
NTBF	New technology-based firms
OECD	Organization for Economic Co-operation and Development
PPP	Public-private partnership
R&D	Research and development
R&D&I	Research, development and innovation
RTD	Research and technical development
SBIR	Small Business Innovation Research programme (U.S.)
SME	Small and medium enterprise
Tekes	The Finnish Funding Agency for Technology and Innovation
TIP	Technology Innovation Programme (U.S.)

1 Introduction

The European Union (EU) is determined to ensure the development and prosperity of the European commonwealth for the decades to come [1]. Viable economic development and leadership in science and technology are important enablers in achieving such goals. These two worlds are also closely linked. Investments in research need economic resources, and research-based technology provides a means to achieve economic growth [2].

In order to accelerate and foster this symbiosis the EU employs various mechanisms supporting research and development (R&D). The collaboration between public and private entities is a key element within these, and has a critical role in striving towards the ambitious goals. As the Framework Programmes for Research and Technological Development (usually referred just as Framework Programmes or FP with the related number following behind) are main research support structures organized by the union, there is considerable emphasis to engage industries and enterprises to participate in them.

The industry participation is often connected to large enterprises with their extensive R&D resources. However, the vast majority of the turnover, employment and even innovation in Europe can actually be attributed to small and medium sized enterprises (SMEs) [3, 4]. Thus, in order to fully unleash the potential of public private research collaboration, these companies need to be addressed. In general, smaller companies have fewer resources and require more support from the organizing side [5] so without active measures the majority of industry collaboration ends up done with the big players. To add to the challenge, SMEs vary greatly in their orientations, capabilities, interests and growth figures, so typically one size does not fit all in policy design. Thus, the analysis has to start with what is actually wanted from the collaboration, why it's done and only then make conclusions on how it should be done.

These challenges are also faced in the Future Internet Public Private Partnership (FI-PPP), which is an undertaking funded under the Seventh Framework Programme (FP7) and aims to explore the opportunities in economic, environmental and social development offered by the development of the Internet. FI-PPP is coordinated through CONCORD project run by Center for Knowledge and Innovation Management at Aalto University School of Economics. One of the tasks assigned to CONCORD is to help the use case projects within the PPP in stakeholder engagement, with SMEs being one of the key stakeholders. Thus, this thesis aims to support FI-PPP in SME engagement. As the form of activity funded under Framework Programmes is projects, the focus is on project-oriented collaboration that involves small and medium sized businesses. [6]

1.1 Research questions, objectives, structure and scope

In order to provide the support mentioned above, the main research question to be answered is:

- *How can the small and medium enterprises be engaged in collaborative public-private research and development projects?*

This question can be further supported by the following sub set of questions:

- *What, if any, benefits can be achieved by increased SME involvement?*
- *How should the SMEs be categorized from the R&D collaboration perspective?*
- *How should EU funded R&D schemes be developed to increase SME involvement?*
- *What possible measures could be taken to ensure successful SME engagement in the FI-PPP projects?*

Addressing these questions aims to achieve the objectives set for the study. The objectives are 1) forming a picture of the important theoretical concepts, current situation and previous measures and recommendations 2) assembling set of recommended SME engagement measures in general and to implement in FI-PPP. Although these objectives do work step-wise and form a continuum, they are also independent deliverables.

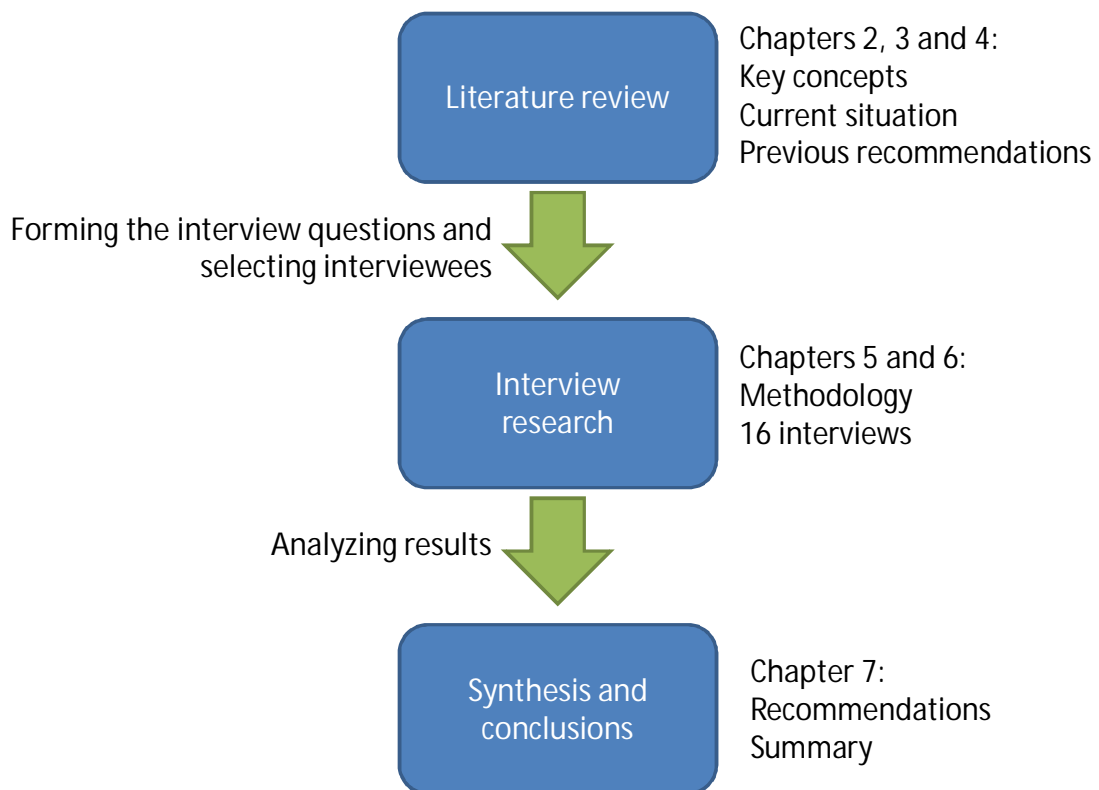


Figure 1: Structure of the study

The structure of the study consists of three parts. The first part consists of extensive literature study, which covers academic literature and previous studies and reports on the topic. Findings of the literature review were used in constructing the interviews, on which the second part is based on. The aim is to reflect the findings of the literature study and collect views that might be missing in the written material. The experts interviewed represent different stakeholders both external and internal in regard to FI-PPP. The analysis of the interviews together with other conclusions then forms the third part. The relation of research questions, objectives, structure and methods is shown in Figure 1.

The scope of the study is limited by the interests of the FI-PPP programme. Geographically, the focus is on the European Union, with natural bias towards Finland, since majority of the interviewees were either Finnish or from Finland based organizations. Research on other areas is limited to brief comparisons. Even with the European focus, it should be kept in mind that this study can by no means cover all the research and previous literature from the EU, even less outside it. Considering different industry sectors, none are directly ruled out, but there is some bias towards the ICT sector. This is derived from the context of the study – Future Internet. The generalizability of results is evaluated for these factors separately.

The main focus is on SMEs *an sich*, not in relation to large enterprises. Thus the research and questions are not set-up around comparisons between small and medium enterprises and big companies. Large companies have however significant role in setting up and executing collaborative R&D projects, so some comparison and reviews are made.

1.2 *Research methods*

The methods used in this study are literature review and interviews. Existing literature is surveyed for established data such as statistics and empiric results, models and frameworks such as enterprise taxonomies and conclusions and suggestions such as policy recommendations and action plans. The sources fall in general in four categories. *Academic textbooks* are used to build introductions in the themes involved and as sources for general models. *Peer-reviewed articles* are also reviewed for such models. *Reports and studies* by the European Union and other public and private organizations are the main source of most up-to-date data about activities of different stakeholders. *Periodic publications and manuals* by public organizations such as OECD and EU are then the source for statistical data and official definitions. Literature review covers Chapters 2, 3 and 4 of this study.

The empiric part of the study relies on qualitative methods. Qualitative approach was chosen since it suits the aim well as the study is about deepening the understanding on the topic. In order to provide relevant new information, the quantitative survey would have needed to be quite large too, and thus not feasible with the resources of this study. Chapters 5 and 6 cover the empiric part of the study.

The main method chosen for collecting the data is thematic, semi-structured interview [7]. Thematic interview lacks the strict order, setting and answer formulations of the structured interview, but it is not totally free either [7]. The idea is to focus on the selected theme or themes instead of detailed questions and answers. The interview arrangements are described in more detail in Section 5.2.

1.3 *About the case*

Although this thesis is not a case study as such, it is aligned according the needs of the CONCORD project at the Center for Knowledge and Innovation Research at Aalto University School of Economics. CONCORD is a coordination project within FP7 funded Future Internet Public Private Partnership (FI-PPP) programme. FI-PPP aims to increase effectiveness of business processes and infrastructures that support applications in areas such as transport, health and energy and to derive innovative business models to strengthen European competitiveness in sectors such as telecommunication, mobile devices, software and services and content provision. As the name suggests, the programme's founda-

tions lie in the key role of the internet for economy and development and in overcoming the limitations of current internet technologies. [6]

Launched in 2010, the FI-PPP is set to follow industry driven, holistic approach and to promote experimentation in real application contexts. The programme is structured around three phases and eleven projects. Three of the projects have a special supporting role: CONCORD is responsible for programme facilitation and support, INFINITY [8] charts the related infrastructures and FI-WARE [9] defines the technology foundation for the programme. The remaining eight projects are so called use case projects. They are set to research and develop applications that utilize future internet technologies and at the same time to determine the requirements for these technologies. The themes vary from agriculture to energy sector and from logistics to urban safety. Based on these eight use cases up to five use case trials will be later launched and then expanded in the final phase. The time span of the whole FI-PPP is from 2011 to 2015, and the overall budget is 300 million euro divided among three calls [10]. The structure of the programme is illustrated in Figure 2. [6]

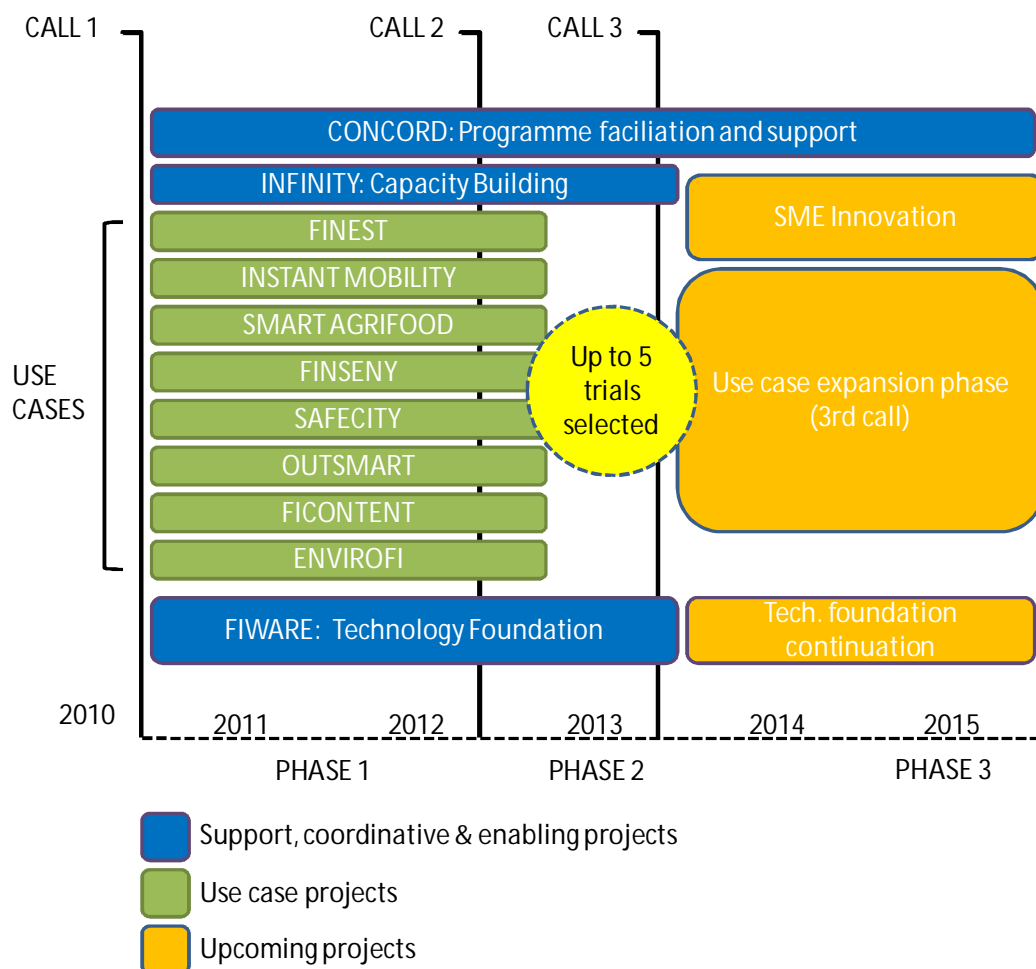


Figure 2: FI-PPP Programme structure and timeline (modified from [6])

One of the themes emphasized throughout the programme is stakeholder engagement, and one core stakeholder type is the SMEs. As a FP7 funded programme the FI-

PPP and its sub-projects have certain requirements for SME funding shares in general (see Section 2.3.1 for details) but there is special interest and emphasis on SMEs also besides this in the programme. The role of the SMEs is further highlighted as the phases advance. One of CONCORD's tasks is to deliver guidelines to the other projects on how to address SME-related challenges [11] and the aim of this study is to support this task. The perspective is two-folded as both the higher level programme perspective and more grass root level of the individual projects are addressed.

Of the eleven projects, three (CONCORD, SMART AGRIFOOD and INFINITY) are coordinated by universities or research institutes and the remaining eight have coordinators from the industry [6]. Thus, the role of privately and publicly owned companies is very significant in the project – something that needs to be kept in mind when analyzing the different development options.

Another significant remark relating the case is that the rules regulating and controlling the commission funding have already been set for the Seventh Framework Programme and will not be any more altered. The planning and discussion is now going on for the next FP, named the Horizon 2020 [12]. Thus within the FI-PPP implementing the recommendations which this study suggests is limited to the recommendations that are compatible with current rules and regulations.

1.4 Results

The results of the study are presented in detail in Chapters 6 and 7, which cover the analysis of interviews and the synthesis and conclusion for the whole study. According to the study, increased SME involvement is beneficial both for the projects and the SMEs, but a lot has to be done to achieve significant increase in the quantity and quality of SME engagement. To support this, three new approaches and a set of recommendations were developed according to the interview and literature review results. These approaches cover the necessary special support, communication and project planning strategies. Although some recommendations were made, this study could not produce broad or detailed set of measures to be implemented within the FI PPP. The conclusive comment on the categorization of SMEs is that while it is useful and necessary to understand the variety of SMEs, there seems not to be need for systematic categorization of SMEs for the purposes of collaborative R&D project design.

2 Publicly funded collaborative R&D

Before diving into analyzing how small and medium enterprises are engaged in publicly funded research and development efforts, the context has to be explained and introduced. The role and meaning of research and development, different innovations and structures of co-operation of public and private actors are explicated in this chapter. The same is done for the other entity – the SMEs – in the beginning of Chapter 2.

This study focuses on the European Union, so complementing the basic definitions, the R&D structures and mechanisms of the European Union are unraveled in this chapter as well. Special emphasis is on the Framework Programmes, especially FP7.

2.1 Innovation and R&D

There are many varying definitions for innovations. Some are broad, such as "*The successful exploitation of new ideas*" [13] or "...*the successful production, assimilation and exploitation of novelty in the economic and social spheres*" [14]. Some go a bit more into detail, like "*the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or service*" [15]. The main things are the requirement of novelty and distinguishing innovation from invention. The general definition used here is that invention is a new idea, and innovation is invention accepted by the markets, and thus put to use.

To gain competitive edge through new innovations, the options for an actor are either to innovate or imitate [2]. Imitation means copying innovations from those who created them, and might seem as a lucrative option, since it typically needs less resources [2]. But imitation has its limits. Naturally someone has to innovate in order for anyone to be able to imitate. According to classic theory by Schumpeter [16], innovations are the main driver of the economic growth and shape the economy through creative destruction [16]. Only by innovating can an actor maintain its competitiveness in the long run [17, 18]. Today, it's generally realized, that a company unable to innovate is destined to perish [19].

As said, innovation is quite broadly defined. To discuss and differ between different kinds of innovations, various typologies have been presented. Firstly, not all innovations are *technical* in nature. Indeed, *social* innovations are often even more powerful in their impact [15]. The technologies enabling the Internet have changed our communications, but the impact is nothing compared to such social innovations as the freedom of speech or free-trade. Another way to distinguish between innovations is to separate *product innovation* and *process innovation*. The former means changes in the things company offers, the latter a change in the way it provides these things. *Service innovation* can further be distinguished from product innovation according to the nature of the supplied value. [17, 20]

Yet another dimension in innovation is the degree of novelty. *Incremental innovation* is improvement in characteristics of something without changing the nature of it, whereas *radical innovation* is revolutionary instead of evolutionary and brings about radical changes in its context [17, 20]. Incremental innovation develops an industry constantly step-by-step, whereas radical innovation brings about disruptive changes that can alter the whole industry [17, 20]. It should be noted however, that the significance arises from perceived novelty and depends on context – a mature technology on one field can turn into a transforming innovation on another. [20]

A fairly recent change in how innovation is perceived and pursued has been the introduction of the *open innovation* paradigm [21]. The concept builds on the idea that in

order to success in innovation, firms can't rely only on their internal resources but need to utilize also external sources of knowledge, ideas and innovation [21]. As this study addresses collaborative research and development, open innovation is an important concept to understand.

The systematic pursue of innovations is then called research and development (R&D). Again, the exact definitions vary, but the general meaning is fairly obvious. OECD [22] defines it as "*Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use, of this stock of knowledge to devise new applications.*" whereas Statistics Finland states it as systematic activity to increase knowledge and applying knowledge to discover new applications [23]. From economic perspective R&D means devoting productive resources into creating new technologies, thus decreasing current production for the benefit of future production [2].

R&D can be formal or informal in nature; depending on whether it is done with officially devoted personnel and time resources. Also, the term R&D covers three types of activities: basic research, applied research and experimental development. Basic research is research conducted to acquire new knowledge through experimental or theoretical work without aiming to any particular application or use. Applied research differs from this in the way that it is directed primarily towards some preset use or applicable objective. Experimental development is development based on existing knowledge or practical experience and aims to produce new materials, products or devices, to install new processes, systems and services or to improving substantially those already produced or installed. [22, 23] Applied research can further be divided into precompetitive research and near-market research, with the former being few years removed from the market phase. The latter is typically confidential and advances purely the interest of the individual firm [24].

Considering the use of terminology, in this study the term R&D is extensively used for research and development and considered as a parallel term with RTD (research and technical development), R&D&I (research, development and innovation) and research and experimental development. Thus, the term R&D is used to describe research and development activity and considered to include innovation, since innovation is the goal of R&D.

2.2 Role of public funding

As mentioned with the open innovation paradigm, companies can gain competitive edge by utilizing external knowledge. This external knowledge can be obtained from and shared with either other private enterprises or public entities. Besides the enterprise perspective, also the public sector has interest in collaboration with industries in R&D. This section describes first the nature of publicly funded R&D in general and then continues to explain the existing collaboration and funding structures and mechanisms in the EU. This is complemented with a brief overview on other regions.

As said, R&D is an investment that devotes resources to something but also away from something [2]. It also includes risks. It thus makes economic sense for a company to share these costs and risks. There are also other and more specific motives for R&D collaboration. A study by Hagedoorn [25] presents an overview on rationale of strategic technology partnerships. Motives related to basic and applied research and general characteristics of technological development include issues such as reduction and sharing costs and uncertainty of R&D as well as the challenges introduced by increased complexity and inter-

sectoral nature of new technology. Motives related to concrete innovation processes have a more straightforward tone; as such motives include capturing partner's tacit knowledge, technology transfer and technological leapfrogging. Examples of motives related to market access and search for opportunities include monitoring of changes and opportunities, internationalization and expansion of product range. Hagedoorn concludes that the motivation falls generally in two categories: market and technology related motives [25]. Although the original study only addresses interfirm partnership, the results apply in general in public-private collaboration as later literature [24] confirms. The market vs. technology orientation in motives is revisited in Section 3.4.4 as SME classification is discussed.

The motives to R&D collaboration can also be divided in strategic and tactical ones. Strategic motives are such as leadership and learning, whereas the tactical ones are such as reduced costs, time and risk of undertaking R&D [20]. Learning requires intent to learn, receptivity to knowledge and transparency of partners [20]. Of the many forms of collaboration, most relevant for this study is the type that is formed around research consortia. It consists of organizations working together on a specified project. Such projects aim typically to perform pre-competitive research or setting standards. The motives behind joining a consortia are sharing expertise, standards and funding, whereas the transaction costs include knowledge leakage and subsequent differentiation (considering standards) [20].

Globalization seems to have highlighted the need for participation. It creates new competitors as well as new incentives and opportunities [26]. Especially on the ICT sector, firms have a growing need to be aware of the innovation systems beyond their own environment and also maintain proximity with their competitors [27]. R&D collaboration offers one way to achieve this [27]. Globally, R&D partnerships are growing and the trend has been towards more flexible and short term projects [28].

Thus, there are varying reasons of interest for the private side to participate to cooperate in R&D. Availability of public funding should only make such activity more lucrative. But why should the public sector invest in private R&D or participate in R&D otherwise? The fundamental reasoning rises again from economics. In general, technology - created through R&D - is the fundamental driver of economic growth and development [2]. But firms acting in their own best interest will invest less than the socially optimal level of R&D [29]. Public support is needed to correct this market failure [29]. Public support can be in various forms such as loans, directed funding schemes and project-based collaboration.

Independent on what is seen as the optimal state, the fact is that much of the cutting edge research is done by universities and other research institutions that are typically public actors. As the definition above stated, the results of scientific research need to be put into use in order to become innovations. This requires technology transfer between academia and markets, in which one way is the public-private R&D collaboration.

The market failure perspective is however only one rationale behind public-private R&D collaboration. A model by Bozeman [30] describes three paradigms for the public participation. The *market failure* model emphasizes the capability of the industry to innovate, whereas the two other paradigms, *mission* and *cooperative technology*, point out a more active role for the public actors. The former builds on the idea that public R&D activity and support should follow programmatic missions set by the officials, whereas the latter sees that government laboratories and universities can play a role in developing technology for the use in the private sector, especially in the case of pre-competitive [30]. The paradigms are presented in Table 1. For the purposes of this study these paradigms are not necessary to view as competing ideologies but rather as different motivations behind public

R&D support and participation. For public-private R&D collaboration justification is naturally found from the mission and cooperation oriented views.

Table 1: The paradigms of public R&D support (modified from [30])

Market Failure	Mission	Cooperative Technology
Core assumptions		
<ul style="list-style-type: none"> -Markets are the most efficient allocator of information and technology -Government laboratory role limited to market failures such as extensive externalities, high transaction costs and information distortions. -Innovation flows to and from private sector, minimal government or university role 	<ul style="list-style-type: none"> -Government role should be closely tied to authorized programmatic missions of agencies -Government R&D limited to missions of agencies. University R&D supports economically important sectors. -Government and universities not competing with private sector in innovation and technology, but act in complementary role. 	<ul style="list-style-type: none"> -Markets are not always the most efficient route to innovation and economic growth. -Global economy requires more centralized planning and broader support for civilian technology development. -Government laboratories and universities can play a role in developing technology, especially pre-competitive technology, for use in the private sector
Peak influence (U.S.)		
- Highly influential in all periods	-1945-1965, 1992 onwards	-1992-1994
Policy examples		
<ul style="list-style-type: none"> -De-regulation -Contraction of government role -R&D tax credits -Little or no need for federal or national laboratories, except in defence support 	<ul style="list-style-type: none"> -Creation of energy policy -Other broad mission frameworks 	<ul style="list-style-type: none"> -Expansion of federal laboratory and university roles in technology transfer and cooperative R&D - Other technology-based economic development programmes
Theoretical roots		
-Neo-classical economics	- Traditional liberal governance with broad definition of government role	-Industrial policy theory -Regional economic development theory

2.3 European Union

As this study focuses on the European Union and its R&D projects, it's necessary to uncover its R&D philosophies a bit. In the *Europe 2020 strategy* [1] the European commission has proposed ambitious goals for this decade, building on three growth priorities: smart growth, sustainable growth and inclusive growth. One of the key enablers for such growth is investment in research and development, and the proposed target for 2020 is that 3% of EU's GDP should be invested in R&D [1]. Thus there is great interest in improving the innovativeness of the region.

Currently the R&D spending in Europe is below 2 % [1], whereas in the US and Japan it is considerably higher (US 2.79 % and Japan 3.44 %, both figures from 2008 [31]). The main reasons are lower levels of private investment and smaller share of high-tech firms [1]. Also the share of growth oriented firms is lower [32]. However, when single financing entities are considered, the European Commission is the largest research financier in the world [32]. Still, even the share of public R&D support is not totally on par with the leading regions. In the EU-27 the government budget appropriations or outlays on research and development (GBAORD) reached 0.74 % of GDP in 2008, whereas in the US

the GBAORD level was 0.99 % and in Japan 0.75 % in the same year. Japan and EU are currently facing similar rising trends, whereas the US the spending has been declining [33].

There are myriad different R&D support mechanisms in work within the EU and its member states. In an effort to clarify and intensify the European R&D scheme, the European Research Area (ERA) was proposed in 2000 and created in the years following [34, 35]. ERA is composed of all research and development activities, programmes and policies in Europe, which have a transnational perspective included [35]. These activities are designed and operated at regional, national and European levels [35], so ERA is a massive umbrella under which a mixed composition of structures exists. The main European-level instruments are the Framework Programmes (see next chapter), the Structural Funds, the Competitiveness and Innovation Framework Programme (CIP) and the European Institute for Technology (EIT). Besides these instruments directly funded by the European Commission, there are some European level R&D related organizations such as European Organization for Nuclear Research (CERN), European Atomic Energy Community (Euratom), European Space Agency (ESA) and the European Research Council (ERC). The first three are thematic research organizations with comparably long history whereas more recent ERC funds high quality research throughout the academic fields [35]. Another new structure consists of Joint Technology Initiatives (JTI) implementing the agendas of European Technology Platforms (ETP) [36].

As this jungle of abbreviations and terms suggest, the European research and develop scheme is far from unified and simple and lot of overlapping and incomplete definitions exists. For example the CIP has SMEs as its main target and it is stated that it doesn't support research but "*innovation related activities*" instead (research is dedicated to Framework Programmes) [37]. How such activities are defined is not comprehensively clear. For example for a given SME participation in an FP7 research project can in practice consist of innovation related activities only, so these different mechanisms provide partly the same kind of support.

Thus, the structuring a clear overview of European public R&D scheme is challenging, even with the introduction of ERA. The most practical factors when comparing public R&D support structures are source of funding – whether the funding comes directly from the European commission – and the controlling entity – whether the actions are reported to European Commission or to somewhere else. The Framework Programmes are an example of a structure directly funded and controlled by the commission, and described in more detail in the next chapter.

2.3.1 Framework Programmes and FP7

The Framework Programmes for Research and Technological Development, or Framework Programmes in short (FP), are the main instruments for funding of research in Europe [38]. The first Framework Programme was launched in 1984 [39], and currently ongoing is the Seventh Framework Programme (FP7), that runs from 2007 to 2013. Eight Framework Programme is at the moment under development. It is called "*Horizon 2020*" and will run from 2014 to 2020 [12]. The CIP (Competitiveness and Innovation Framework Programme) is another framework programme –titled structure that is separate from the programmes running in numerical order [37]. It has SMEs as its main target [37]. But as FI-PPP, the case programme of this study, is funded under FP7, it is in the focus of this overview. CIP also doesn't fund R&D [37].

The overall budget for FP7 is 53.5 billion euros, with 50.5 billion euros coming from the European Commission and the rest from Euratom. The programme is built

around 4 major blocks of activities or programmes: *Cooperation, Ideas, People* and *Capacities*. Adding to these are the activities related to nuclear research. The Cooperation programme funds collaborative research under 10 themes ranging from health to space. ICT is also one of the themes. The Ideas programme consists of the activities implemented by the ERC, and is thus basically high-level frontier research oriented. The People programme is about training and career development of researchers, and finally the Capacities programme funds research infrastructures. [38] Thus it is the Cooperation block that is of the main interest of this study.

The Cooperation programme has a budget of 32 billion euros, with the largest share (9.11 billion euros) allocated to the ICT theme [38]. The idea is to support cooperation between universities, industry, research centers and public authorities throughout the European Union and beyond as well [40]. As described in Section 1.4 the FI-PPP is funded under the Cooperation programme and ICT theme. The ICT programme is not focused on ICT sector as such, but rather adoption and use of new ICT-based innovations across the economy [38].

The funding in FP7 is granted based on proposals submitted in response to calls for proposals [43]. Thus, the support is proposal-based and the funding is always granted to distinct projects. Across the four programmes of FP7 various funding schemes are implemented with slightly different focuses. Of these, the schemes "*Collaborative projects*" and "*Research for the benefit of specific groups (in particular SMEs)*" [42] are the relevant ones considering the scope of this study. The former is the main mechanism for supporting collaborative R&D projects in which also SMEs can be involved. The latter is a more special scheme where research is undertaken to directly benefit a special group with deficient R&D capabilities – such as some SMEs [42]. The opportunities provided by these schemes to SMEs are discussed in more detail in Section 4.2.

The participants in a collaborative R&D project funded under FP7 form a project consortium. The consortium is usually based on a consortium agreement, which describes the internal organization of the consortium, the distribution of the financial contribution, additional rules on dissemination and use including intellectual property rights (IPR) arrangements and the settlement of internal disputes [42]. The fundamentals of the funding are then defined in the grant agreement between the consortium participants – the beneficiaries - and the European Commission (EC) [44]. Thus, the collaboration is ultimately defined by the grant agreement as well as the established rules for participation [45], and then further specified by the voluntary consortium agreement, which naturally can't overrule or conflict with the other two.

Each beneficiary has its responsibilities related to the consortium and doing their part, but related to the project consortium there are also some defined special roles. The project coordinator is the lead consortium partner (thus one of the beneficiaries), who then has extra responsibility over the project. Coordinator carries the costs of preparing the proposals, is responsible for passing on pre-financing in accordance with the grant agreement and for reporting to the Commission on behalf of the project and monitors the compliance by other beneficiaries with their obligations [46]. To clarify, coordinator here refers to an organization, but persons coordinating a project can as well be titled project coordinators. There can also be a distinct nominated scientific coordinator in charge of the scientific coordination of the work, but from the legal perspective such actor is indifferent from plain beneficiary [47]. The project can also have third parties, which are organizations that are not signed up to the grant agreement, such as subcontractors. In order to charge any costs, they have to be identified in project negotiations and contribute to the project. Each beneficiary is responsible for the performance of any subcontractors attached to them. The

European Commission is represented by a Project officer in the projects [46]. Project officer relies in administrative, legal and financial officers of the European commission as well as external reviewers when monitoring the project. The general organization of a FP7 collaborative project is illustrated in Figure 3.

Providing funding is naturally the main element of the FP7 structure. The funding rates differ according to the beneficiary and purpose. The rate of reimbursement for the collaborative R&D projects is 75 % for non-profit public bodies, secondary and higher education establishments, research organizations and SMES and 50 % for all other organizations (including larger firms) [41, 42, 47]. For coordination and other supportive actions the rate can be 100 % for all types of beneficiaries. The contribution from EU consists of a single pre-financing payment paid at the start of the project, interim payments following each reporting period and the final payment at the end of the project for the last reporting period (includes necessary adjustments). Although the general model of funding is reimbursement for eligible costs, also lump sum and flat-rate funding can be applied in some instances. [47]

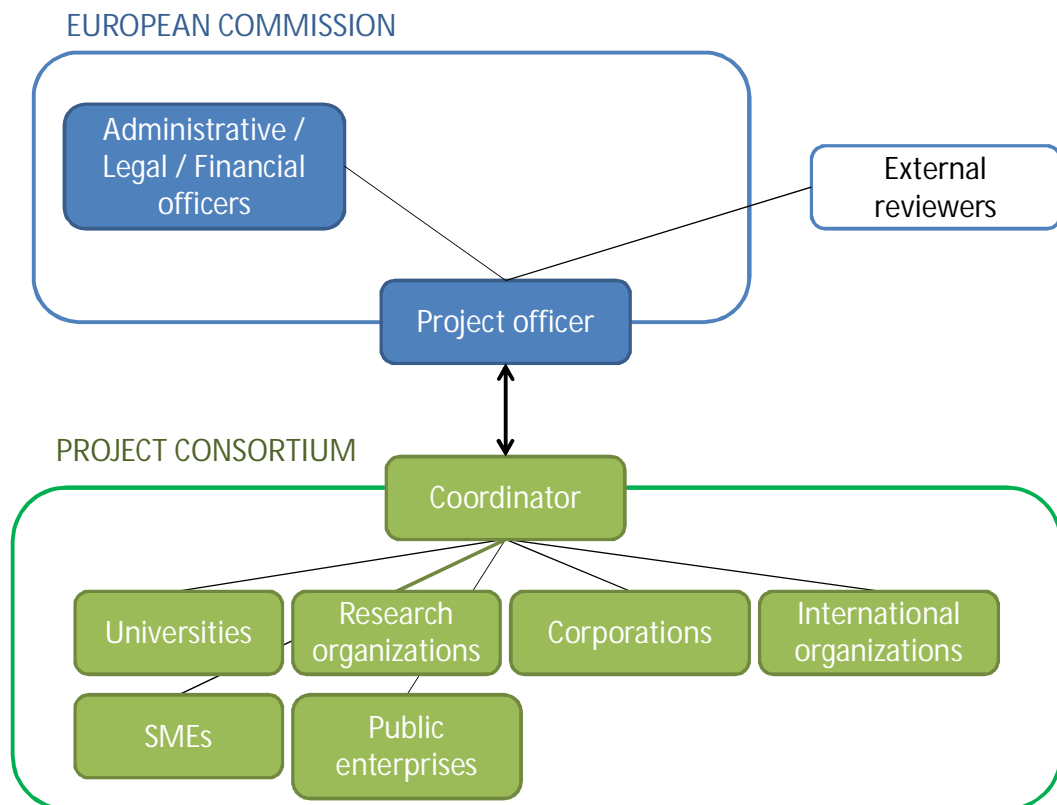


Figure 3: General organization of an FP7 project (modified from [41]).

From SME perspective participation in a framework programme project can be seen as forming of an R&D alliance [24]. The process of participating in an FP7 project is described in more detail in Section 4.2. It should be noted that besides higher funding rates, the SME participation is pursued by setting target funding shares for the whole FP7. The target set for FP7 is that at least 15 % of the funding under the Cooperation pro-

gramme goes to SMEs [48]. The actual statistics of SME participation in FP7 are discussed in Section 4.1.

In comparison to national level R&D programmes, the projects under Framework Programmes are considered more complex, more long-term oriented and riskier from the scientific and technical point of view [32]. The reimbursement rates are considerable higher than for example those of Tekes in Finland [49].

2.3.2 Public-private partnerships

Under the described Seventh Framework programme the European Commission has defined and set certain sub structures with distinct means and goals. One such construct is public-private partnership (PPP), very relevant for this study since it is related to the Future Internet Public-Private Partnership.

Public-private partnership is not a well-defined concept, but in general it refers to an arrangement where public and private actors collaborate in cooperative initiative, typical example being construction and operation of infrastructure [50, 51]. The general setting is that the goal is a public good or development (reducing poverty, providing health care, higher education [52]) and the private businesses, while driven by profits, are used to achieve these goals. The principal roles for the private sector is to provide additional capital, alternative management skills, value added to consumers and the public at large and better identification of needs and optimal use of resources [50]. Private sector extends a PPP's reach and multiplies its impact while adding perspectives, resources and skills [52]. According to the consultancy company McKinsey & Company [52] the PPPs can be grouped into four archetypes: Coordination, Funding, Product development and Delivery, where the names describe their nature. At the moment PPPs are on the rise and utilized increasingly in various regions and sectors [52].

In the EU R&D context public-private partnerships refer to special industry-driven R&D initiatives [53] launched by the commission under the FP7 schemes. At the moment there are four of such partnerships being implemented. Three of these - Factories of the Future (FoF), Energy-efficient Buildings (EeB) and Green Cars (GC) – were launched as a part of the European Economic Recovery Plan [54] and were designed to boost competitiveness and increase employment through funding research and innovation in the manufacturing, constructing and automotive sectors [55]. The fourth one, Future Internet Public-Private Partnership (FI-PPP) was launched later on to address the need to make public service infrastructures and business processes significantly smarter through utilization of Internet networking and computing capabilities [56]. FI-PPP is further discussed in Section 1.4. The Joint Technology Initiatives (JTI) are also considered as long-term public-private partnerships [57] but regularly the term is coined to describe the four PPPs.

The funding and practicalities in these PPPs are in general similar to those of other FP7 projects, but there are some differences too. Each of these four PPPs has multiple individual FP7 funded projects implemented under them, but there is coordination between them. In the three recovery package related PPPs the targets and plans were formed and the coordination is organized together with the European Commission and so called Ad-hoc Industrial Advisory Groups composed of representatives of the industry. [58] In FI-PPP there is no such group, but there is a distinct project CONCORD set for the facilitation and coordination and there is a separate advisory board that represents the industry and academic expertise of the field. There is also a steering board for the PPP, in which all the sub projects are represented and which acts as the highest authority of the FI-PPP. [11]

All in all these EU research and development PPPs can be considered as thematic umbrella structures within the FP7. They exist as a mid-layer between the original FP7 structure and the funded projects providing the commission a mechanism to target funding into sectors and topics considered especially important. Communication and design of these partnerships has however not been totally successful – according to the interim assessment of the recovery PPPs the purpose, structure and relevance have remained unclear to some stakeholders [58].

2.4 Finland

The empiric part of this study relies primarily on Finnish sources. Thus it is necessary to open up the Finnish R&D scheme a bit in order to assess how the findings can be generalized to reflect the whole European Union or even in larger terms. The statistics and characteristics of Finnish research and development activities are described below.

Finland has been a member in the European Union since 1995 and is among the leading R&D investors when compared to the size of the economy. The expenditure as a percentage of GDP was 3.87 % in 2010, which is well above the EU average and tops U.S. and Japan as well [31]. Especially government expenditure is high, but also the business sector is eager to invest in R&D [59]. Finland is also the leading state within the OECD in terms of number of researchers in the labor force [59].

Investments in research and development are likely to explain some of the productivity and economic growth seen in Finland during the last decade [59]. But Finnish innovation landscape has its flaws as well. The gains from R&D investment – new innovations, jobs and exports – have not met the expectations [59]. Most of the R&D is in the hands of large technology oriented companies [59]. Finnish R&D remains somewhat isolated from the outside world, indicated by the low levels of foreign R&D funding and patents involving international collaboration [59]. Also small and start-up companies suffer from the lack of risk capital, and in general there is lack of growth-oriented companies [59]. The entrepreneurial spirit seems to be on the rise however [60], and both the state and private actors have undertaken actions to reinforce the innovativeness of the economy [59, 61].

The main public actor funding R&D is Tekes, the Finnish Funding Agency for Technology and Innovation. State-funded Tekes funds companies and universities through projects. The annual budget for supporting scientific research and R&D is around 600 million euros. This includes direct funding, loans and distributing EU funding from the European Regional Development Funds [62]. Besides financial support, Tekes provides information and guidance services. Tekes is also partly responsible for providing information about the R&D funding opportunities provided by the European Union. [63]

Recently, Tekes has faced serious criticism from various actors including entrepreneurs [64, 65], leading corporate figures [66] and even the National Audit Office of Finland [67]. The critics have implied that too much of the support goes for large companies, that easily available Tekes funding discourages private investments and direct enterprises away from market oriented thinking and that the funding hasn't led to expected results. Currently, 61 % Tekes funding goes to SMEs [68], so at least in comparison to EU programmes the share is much higher. Tekes is also reforming its funding for 2012 and emphasizes internationalization, growth and risk-taking more in the future [69].

In the Framework Programmes of the European Union the Finnish actors don't stand out either as the most active or most inactive. The number of proposals has been in

decline, but the received funding has been on the rise [70]. The share of Finnish participants was 2.1 % of all the project participants of the FP6, in which the Finns were most active in the fields of nanotechnologies and –science and sustainable development and least active in aeronautics and space [70]. The share of participation has remained at the same level in FP7 [71]. The applied amounts and success rates of Finnish actors are on the higher end, but not in the top notch [71]. The participation rate of Finnish SMEs in the EU funded projects is higher than the European average (75 participating SMEs per 100,000 SMEs compared to 46 of EU-15) [72].

2.5 Other regions

Most of the research and development in the world is naturally done outside the European Union. Although there seems to be a global shift towards new areas like BRICS (Brazil, Russia, India, China and South Africa) in the global research and development scheme [59] the most relevant players alongside the EU are still the United States and Japan. The public R&D support structures of these countries are briefly revised in the following. The significance of China can however not be bypassed so its policies are shortly described as well.

The United States is the largest R&D contributor in the world, thanks to both the size of the economy and the comparably high rate of R&D investment [31]. The role of private sector is more significant than in the EU [74]. Also in comparison to the EU or leading European states, the innovation system in the U.S. is highly decentralized, as there is no single entity or policy governing the innovation system or public R&D funding [74]. There are various federal and state level agencies that provide such funding according to their own agendas [74]. Examples of federal level structures are the Small Business Innovation Research (SBIR) programme [75] coordinated by the U.S. Small Business Administration and the Technology Innovation Programme (TIP) at the U.S. National Institute of Standards and Technology.

As the name suggests SBIR is restricted purely to SMEs (by U.S. definition). It receives its funding from the R&D budgets of major federal agencies. The participation in the programme happens in three phases. Phase I aims to guarantee the feasibility and the commercial potential of the project and the company with maximum funding of \$ 150,000 and duration of six months. In Phase II the R&D efforts are continued (max. \$ 1,000,000 and two years), and the funding is based on the result of Phase I. The aim of Phase III is to pursue commercialization – in this phase SBIR does not provide funding, but instead the support can be either direct R&D support from some of the federal agencies or a business contract with a public entity, stimulating public-private partnerships [75]. Thus the programme provides government agencies with new, cost-effective technical and scientific solutions to meet their needs and also leverages innovative small businesses from the perspective of private investors [73].

The other mentioned programme, TIP, is then aimed at businesses of all sizes, as well as research institutions and universities [73]. It aims to support, promote and accelerate innovation in the U.S. by investing in high-risk, high-reward research in areas of "*critical national need*" [76]. The effective use of public funds is pursued through rigorous evaluation of both business and technical experts as well as by requiring that the applicant is responsible for at least half of the costs [73]. The funding is available both for single company projects (maximum \$ 3,000,000 and three years) and collaborative projects (maximum \$ 9,000,000 and five years) [73]. Both the TIP and the SBIR are highly competitive, as only 15-20 % of applicants are awarded funding [73].

Japan is among the top R&D investors in the world, and class of its own among the G8 economies [31]. Private sector is responsible for the majority of R&D expenditures, but both public and private sector research structures are highly developed [77]. Strong international and regional cooperation are emphasized [77]. The Japanese have adopted their own version of SBIR programme, which offers two types of support. Firstly, there research and development support through contract grants and subsidies. The second type is the support for technological application development in form of patent fee reductions, loan guarantees and loans [73]. Another, more unique form of public R&D support is the "Support for Development of Networks between Upstream and Downstream Companies" programme [73]. The programme aims to link technological seeds with market needs by creating networks between innovative R&D oriented SMEs and large established industries. The programme provides coordination, communication and facilitated interaction and is operated by the Small and Medium Enterprise Agency of Japan [73].

China is of course a very different economy compared to the EU, U.S. or Japan, since it is a single-party authoritarian state and still technically a communist state [78]. This means that differing public and private actors is ambiguous since significant share of Chinese industry is state owned [79]. The industrial sector (consisting of commercially active entities independent of the ownership) is responsible for most of the R&D expenditures, although the share of the public sector is higher than in the above mentioned societies [79]. There are some measures taken by the central government to foster R&D and innovation. The Innovation Fund for Technology-Based Firms (Innofund) supports developing newly established technology-based SMEs. It provides subsidies to interest of loan and grants, and the impacts on participant enterprises have been significant in terms of growth. The fund run by central government has since been complemented with multiple similar structures on provincial and municipal level. [73]

Thus, even though European Union is the single largest R&D funder, there are comparable structures and instruments in other parts of the world. In terms of the mentioned Bozeman paradigms [31] the EU Framework Programmes stand out as more mission-oriented. FPs are built around thematic structures and goals more strongly than for example the U.S. SBIR or Chinese Innofund [75]. Although SBIR directs the R&D according to the agency needs, the approach is more customer-oriented than politically driven [75].

2.6 Chapter summary

Innovation is invention put to use, and research and development is the activity of pursuing innovation. In an economy with stabilizing population, developing new technology by investing in R&D is the only way to ensure economic growth. Public support for R&D is necessary to correct market failures, direct the research towards desired goals and to improve technology transfer. Public-private research collaboration builds on these principles, and the European Union has taken an active role in supporting and fostering such activities. The main instrument is project funding through Framework Programmes. The currently ongoing Seventh Framework Programme utilizes different structures within the general project support mechanism, such as public-private partnerships for research. Besides the EU, other leading R&D regions such as United States and Japan have implemented public funding structures for supporting private R&D, and have also targeted support for SMEs.

3 Small and medium enterprises

The previous chapter described the logic and characteristics of public-private research and development collaboration in general. This chapter continues the literature review by bringing the small and medium enterprises into focus. The aim is to give an overview on how and why SMEs participate in R&D collaboration. Special emphasis is also put on how the SMEs can be categorized or classified for the purposes of policy design. Before getting into these topics however, there is an introductory part covering the definition and significance of SMEs, as well as brief introduction to the principles of entrepreneurship, a phenomenon very essential regarding the SMEs.

3.1 Entrepreneurship

Entrepreneurship is one of the buzz words of this day. Besides solving economic challenges such as intensifying global competition and structural changes, entrepreneurship is seen as a key concept in the battle against just about every global challenge from poverty reduction to climate change. It is no longer restricted to businesses, as governments, universities and non-governmental organizations are expected to show entrepreneurial spirit to foster. [80]

Current interpretation of the word entrepreneurship has its roots in the works of Joseph Schumpeter [16] who in his famous work *Theory of Economic Development* describes how it is the entrepreneur who brings innovation (and thus creative destruction and development) into the otherwise stationary economy. Schumpeter derives the definition of entrepreneurship as "*implementation or realization of new factor combinations in the form of new products or new qualities of a known product, new production methods, the opening-up of new sales markets, new organizational form or new forms of procurement.*" [16] Since then, many more definitions have been developed with different focuses and perspectives. Volkmann [81] lists several of these, and summarizes characteristic elements of entrepreneurship as following:

- Identification and exploitation of entrepreneurial opportunities
- Innovation and novelty
- Securing of resources and formation of an enterprise / an organization
- Profit-orientation taking into account reasonable risks and uncertainties

Although comprehensive, this characterization doesn't grasp all the usages of the entrepreneurship concept. Volkmann [81] thus summarizes the concept in a more broad way: "*Entrepreneurship is generally characterized by innovative, entrepreneurial thinking and acting processes which are oriented towards the recognition and exploitation of business chances as well as creating economic value within a new enterprise.*" The more narrow concepts of start-up management and growth management are core areas of the concept [81].

Entrepreneurship is not bound or restricted into small or new businesses, nor is it even limited economic institutions [15]. However, in the context of small and medium sized businesses, the entrepreneurship is perhaps more essential. In general, the smaller the company, the more its actions depend on and reflect the entrepreneur or the entrepreneur team as there is less managerial inertia [82]. Thus, entrepreneurship is an important underlying theme when studying SMEs.

The research on entrepreneurship can be categorized into three approaches [81]: 1) *traits approach*, focusing on the distinct psychology of entrepreneurs, 2) *functional approach*, researching the role and output of entrepreneurs in the economy and 3) *behavioral approach*, which describes the actual behavior of entrepreneurs defining the nature of what constitutes entrepreneurship. This study mainly relies on functional approach in considering the significance of the topic and behavioral approach in studying the practices to engage to enterprises.

3.2 SME Definitions

As this study explores the engagement of small and medium enterprises in the R&D projects of the European Union defining what is meant by SMEs is essential. Naturally, the definition set by the EU is the most important in this context, but as the definitions are always more or less arbitrary, it's useful to review other definitions as well.

The definition set by the EU for an SME is a company that employs fewer than 250 persons, has annual turnover not exceeding 50 million euro and/or an annual balance sheet total not exceeding 43 billion euro [83]. The same recommendation that sets this definition also defines a typology describing the level of autonomy. An SME that is either completely independent or has minority partnerships (each less than 25 %) is considered autonomous. If the level of holding rises between 25 % and 50 % the SME is considered as a partner enterprise with the other party. Above than that share, the enterprises are considered linked [83]. As an exception in the case that the outside owner is public investment corporation, venture capital company, business angel, university, non-profit research centre, institutional investor or small local authority the threshold for autonomy is 50 % [84]. Only the autonomous SMEs are considered genuine SMEs that are eligible to all the support schemes targeted for small and medium enterprises [85].

The SMEs are further classified in classes according to their size. A microenterprise is an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total doesn't exceed 2 million euro [83]. A small enterprise is an enterprise that has fewer than 50 employees and whose annual turnover and/or balance sheet total doesn't exceed 10 million euro [83]. Companies bigger than this but still within the SME limits are then considered medium-sized [85].

The status of the EU definition is an official recommendation. That is, the use of it is voluntary and its contents can be adapted to suit national conditions [84]. The definition has however been applied throughout the member states without notable difficulty [86]. For example the Finnish authorities use the EU recommended definition as such [87].

But, as said the definition is in the end arbitrary. In the United States the definition of small business (which is the term used typically by the U.S. Small Business Administration instead of SME) is broader and more varied. In general, a company qualifies as small business if the number of employees doesn't exceed 500 and the average annual receipts is below 7 million dollars [88]. There are however significant variations in the definition between different industries. In some manufacturing sectors (e.g. ammunition manufacturing and aircraft manufacturing) the upper limit is 1,500 employees, whereas in wholesale trade the employee limit is in general 100 employees [89]. The requirement for independence is also present in the U.S. definitions [90].

In Japan, the definition also varies according to sector, varying between maximum of 300 employees (e.g. manufacturing and construction) and 50 employees (retail trade) [91]. Besides employee quantity, the total amount of capital or investment is used as the

classification measure, with the maximum value ranging between 300 million yen and 50 million yen [91]. In China, the small enterprises and medium enterprises are defined separately, with upper limits also varying according to the industry [92]. The maximum number of employees varies between 100 and 600 for small companies and between 100 and 3000 for medium sized companies. Maximum volumes of business revenues are also set [92]. A comparison between different SME definitions is shown in Table 2.

Table 2: Different SME definitions

European Union [83, 84, 85]	United States [88,89,90]	Japan [91]	China [92]
<p>SME</p> <ul style="list-style-type: none"> • Less than 250 employees • Turnover less than 50 million euro • Annual balance sheet total less than 43 million euro • Autonomous: external ownership less than 25 % • Sub-division in micro, small and medium enterprises 	<p>Small business</p> <ul style="list-style-type: none"> • Less than 500 employees • Average annual receipts below 7 million dollars • Independent • Exact limits vary according to the industry 	<p>SME</p> <ul style="list-style-type: none"> • Exact limits vary according to the industry • Max. number of employees from 50 to 300 • Max. amount of capital or investment from 50 to 300 million yen 	<p>Small enterprise</p> <ul style="list-style-type: none"> • Exact limits vary according to the industry • Max. number of employees from 100 to 600 • Also revenue limits <p>Medium enterprise</p> <ul style="list-style-type: none"> • Exact limits vary according to the industry • Max. number of employees from 100 to 3000 • Also revenue limits

Thus, the answer to what is an SME depends on who is asked. The upper limit of 250 employees was adopted by the EU in the recommendation predating the current one, set in 1996 [93]. The comparably low figure was justified by the noting that enterprises between 250 and 500 employees often have very strong market positions and also possess very solid management structures [93]. It was also noted that a threshold of 500 employees would encompass almost all enterprises (99.9 %) and three-quarters of the European economy, and thus not be truly selective [93]. All in all, the lower threshold was seen to provide a more meaningful reflection of the reality of an SME [93]. Suggestions to redefine the SME definition have been presented within the EU, including proposing a new category for enterprises larger than 250 employees but smaller than true giant corporations [86]. The changes have thus far been discarded [86]. For the purposes of this study, the SME definition of the European Union is used.

3.3 *Significance in the economy*

Although the traditional economics that prevailed through most of the 20th century put little emphasis on the significance of small firms in the economy, the view has changed

radically during the last couple of decades [94]. Today, the importance of SMEs is largely recognized, and this view shapes policies as well [1, 73].

Current view is that new and small firms act as the most dynamic element of the economy [94]. Compared to large enterprises, small businesses create more employment, but also many jobs disappear with them, as both the mortality and birth rates are high [20, 94]. However, their cumulative effect is positive on job creation [94]. Small firms also play important role in innovative activities, especially on new product innovations [94] and breakthrough innovations [95]. The lower investments on formal and full-time R&D are compensated in informal, part-time and non-measured R&D [20] as well as reduced bureaucratic inertia and less resistance to new ideas [94, 100]. The share of innovations by small enterprises also differs between different sectors [20].

The statistics from the European Union support these presumptions quite clearly. SMEs account for 99.8 % of all companies in the EU and they employ around two-thirds of all the employed persons [3]. Figure 4 shows the comparison between size classes and their share of enterprise population and employment. The share of value added was 57.6 % of the total value added [3]. Even though the apparent labor productivity is generally lower in SMEs than in large firms [3], SMEs have shown to act as the backbone and main driver of growth in the whole economy in Europe [4]. Across EU, among large firms there are more innovative firms than among SMEs, although there is some variation between countries [96]. The difference is even clearer in product than process innovation [96]. The contradiction with theoretical assumptions is likely resulting from summing up all SMEs as one group – the growth oriented, innovative SMEs are still most likely the most significant contributor to radical and high-impact innovation [97]. They drive the economy not only through direct actions, but also indirectly by increasing competitive pressure on incumbent firms [97]. The differences between innovativeness of SMEs are explored in more detail in Section 3.4.3.

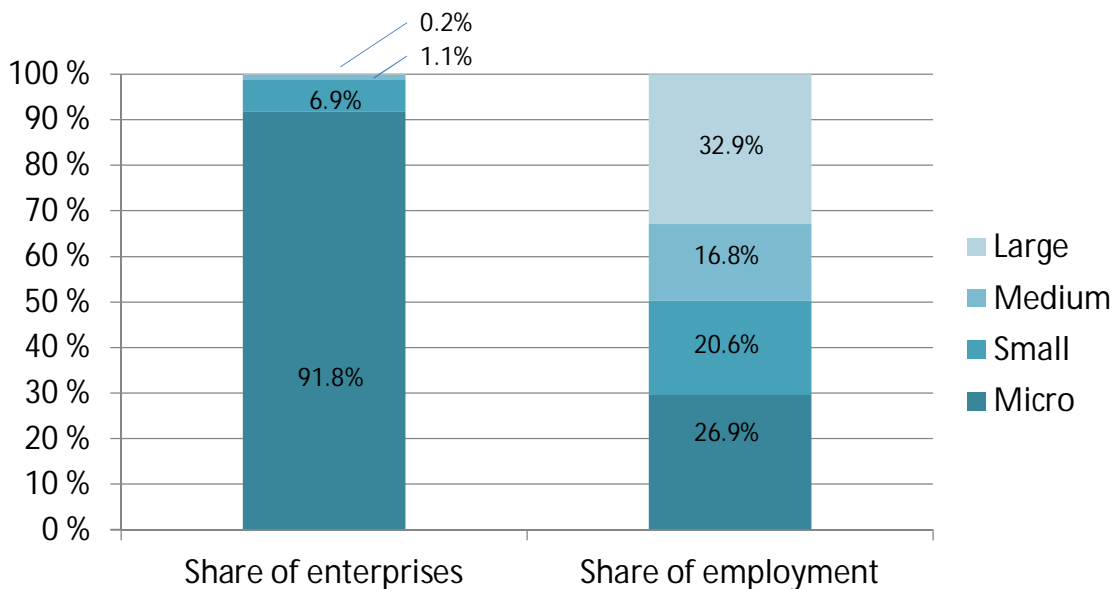


Figure 4: The share of enterprise population and employment by size class (data from [3])

In Finland the enterprise demographics are similar to the rest of EU. SMEs account for 99.8 % of all the companies and provide 64 % of all the jobs [98]. The share of added value is however slightly lower, with SMEs creating only 51 % of it [98]. The role of SMEs in economic growth has followed the European trend [4] as well as the share of innovative enterprises among SMEs [96]. Lack of growth oriented start-up companies is however seen as a problem [99].

Thus, even though the productivity figures of SMEs don't reach those of large enterprises and the innovativeness is not as prevalent on average, the new businesses and SMEs have a critical role in the economy. They form the largest bulk of the private sector and among them lies the strongest capability to renew and revolutionize the economy by introducing breakthrough innovations and by providing flexibility and dynamism. [73]

3.4 SME classifications

In order to develop efficient policies and practices to involve, engage and empower small and medium enterprises, their behavior and nature needs to be understood. It is however clear that not all SMEs act alike. By definition, they share some characteristics, but differ in others. In this section previous literature is reviewed for different categorizations of SMEs according to various dimensions. First, more general classifications defined by established literature are overviewed. This is followed by groupings related more to the context of this thesis. The main emphasis is on the ways to group SMEs based on their innovation capabilities and characteristics of their participation in public-private R&D collaboration.

One way of categorizing SMEs further is to group them according to their size, as described earlier in Section 3.2. Although this is useful also regarding policy design, it is generally not enough. Thus, many suggestions have been made on how to separate small and medium companies according to their actions, characteristics, leadership philosophies and so on. Some of the classifications are based on one dimension only; some are based in collecting and comparing multiple attributes. The latter kinds of taxonomies are usually built through cluster analysis.

Some of the previous research is based on specific case studies or surveys some refer to a larger set of data or broader generalizations. Naturally the studies regarding SME activity in EU research schemes have been focused on European firms, so altogether this review has a slight European bias.

3.4.1 Classification by sector

Together with the size, perhaps the most relevant attribute of a firm comes from what does it do. In general, a company serves customers to create and capture value, but typically acts only on one or few fields of the economy. Although significance varies according to the industry, SMEs dominate are represented and are most numerous in all fields of private business [3].

One way of categorizing enterprises is the division to manufacturing and services according to their basic business model. SMEs play an important role in both of the sectors, which seem to share the basic fundamentals in the innovation process [100]. Also, the boundaries between manufacturing and services have been blurred and they are more and more integrated [100, 101]. Thus, from the perspective of this study, the division based on manufacturing-services-division is fruitless.

Another way of classifying would be to separate high-tech companies from non-high-tech companies. High-tech can be defined in various ways, looking at the products, patents or whole sectors of industry [102]. High-tech industries comprise of high-tech manufacturing and high-tech knowledge intensive services [102]. Although these sectors are obviously more strongly driven by cutting edge technological development than some others, the prevalence of advanced ICT and other high-tech in everyday life and business today means that high technology is relevant for SMEs regardless of market or field of business [103]. According to OECD, R&D intensity is the sole criterion for assessing whether a sector is considered high-tech or not [104]. Perhaps a more differentiating factor for classification would then be R&D intensity of a individual SME, discussed later in Section 3.4.3. A well-known taxonomy of companies according to different sectors and their innovation capabilities is the one by Pavitt [105]. That and its derivatives are also covered in Section 3.4.3.

An established way to categorize industries in Europe is the Statistical Classification of Economic Activities in the European Community (NACE – for French Nomenclature statistique des activités économiques dans la Communauté européenne) [106]. It provides a four-level system to categorize the field of business for a company, such as 'C27.1.2 - Manufacture of electricity distribution and control apparatus', where C stands for manufacturing, 27 for electrical equipment, 1 for electric motors, generators, transformers and electricity distribution and control apparatus and 2 for electricity distribution and control apparatus [106]. Thus, NACE codes are suitable for defining industry sectors on different levels.

However, as described the FI-PPP as a project covers multiple sectors of industry, all of which have are not yet even known. Thus, it serves no purpose to limit this study to certain sectors of industry or economy by default. Still, sectoral categorization can be necessary and helpful on some occasions.

3.4.2 Classification by growth orientation and stage

As discussed in Section 3.3 the small and medium enterprises contribute largely to economic growth and job creation. This being the case, the macroeconomic growth comes from the growth of the individual firms. The SMEs however vary greatly in their attitudes and aspirations towards growth. The inclination towards growth-orientation is one of the fundamental characteristics of a firm, and thus one way to categorize businesses. Still, growth is not a state but a direction, so growth companies go through various stages during their growth. Firms in different stages of growth have different needs, so any effective policy should be able to take into account this temporal dimension. This section describes different classifications based on growth orientation and stage. They are summarized in Table 3, and discussed in detail below.

Byers [107] has defined a categorization of different types of firms according to their growth orientation (originally defines types of new ventures, but the analysis is fairly practical on SMEs on general as well). In this taxonomy, five types of businesses are recognized. *Small businesses* have slow revenue growth, and are planned to stay small. They are usually run under sole proprietorship or as a family business, and the objective is to provide economic independence and wealth by serving customers. Typical examples could be consulting firms or local book stores. *Niche* businesses exploit limited opportunities or markets, with the objective to provide steady growth and good income. They have slow to medium growth pace and the planned size is small or medium. On occasion, niche firms grow over time into large, important enterprises. *High growth* companies are set to create important

new businesses, often by seeking disruptive and radical innovations. By nature, they usually need large initial investments. The aimed growth rate is fast and planned size is from medium to large. The remaining two types of companies are then slightly different in their origins. A *nonprofit organization* exists to serve social need. Revenue growth is likely to remain slow and size small. *Corporate new venture* is an independent new unit of an existing company, aimed to build a new business unit or a separate firm. They are planned to grow to medium or large size with medium to fast revenue growth. For the purposes of this thesis, it should be noted that such corporate new ventures don't generally classify as SMEs.

Table 3: Summary on categorizations based on growth orientation and stage

Byers [107]	Kaplan [108]	Volkman [81]	Birch / OECD [109] [110]	Timmons [112]	Smilor [111]
Small businesses: Stay small Niche businesses: Exploit limited opportunities High growth companies: Disruptive & radical innovations Nonprofit organizations: Serve social need Corporate laboratories: Connected to big firm	Conducting the opportunity analysis Stage of developing the plan and setting up the company Acquiring financial partners and sources of funding Determining the resources required and implementing the plan Scaling and harvesting the venture	Young ventures: Internal and external deficiencies, but also advantages fast decision making, commitment, flexibility	Gazelle: Innovative successful high-growth company, 20% annual growth	R&D stage: Investigation of idea and business model. Start-up stage: Earning customer and investor confidence High-growth stage: Determination of success or failure Maturity stage: Profitable growth Stability stage: Growth stabilizes	Lifestyle entrepreneur: Earning a living Growth entrepreneur: Focus on fast growth Aspiring entrepreneur: Looking for opportunity

Clearly belonging to Byers's [107] high growth category but with more specific definition, a *gazelle* [109] is an innovative successful high growth company. Originally named and defined by David *Birch*, gazelle is a company that has achieved 20 percent annual sales growth with a starting base of at least \$ 100,000 [109]. According to some studies gazelles are the most important innovators and job creators, being responsible for huge majority of radical innovations. [109] *The OECD* [110] has also made definitions for high-growth and gazelle companies: a high-growth company has annualized growth greater than 20 % per annum for a three year period. The growth can be measured either by number of employees or turnover. The gazelles are then a sub-category of these high growth companies that are at least 5 years old [110].

Another division between different enterprises is made by *Smilor* [111], which emphasizes the vision of the entrepreneur as the source of difference between different types of enterprises. This approach defines three types of entrepreneurs (and the according enterprises). *Lifestyle entrepreneurs* run enterprises that fit their individual circumstances and styles of life. Intention is to earn a living, and growth is not pursued. In comparison, *growth entrepreneurs* run companies with both the desire and the ability to grow as fast as possible and as large as possible. Such enterprises are also the most dynamic job generators in the economy. The third category, *aspiring entrepreneurs*, refers to the entrepreneur-minded individuals still looking for their chance to start a business. [111]

In literature considering entrepreneurship and small businesses, there tends to be emphasis on new, young ventures. Although growth orientation might be more relevant attribute, division based on company age can be useful as well. For example *Volkman & al.* [81] list typical characteristics of *young ventures* – defined by age (not older than three years) and stage (break-even point not yet reached, no internal cash flow sustainability). Such companies tend to have certain internal and external deficiencies. Internal liabilities include lack of established organizational structure, scarcity of management time and resources, problems to implement full scale business operations, limited financial flexibility and competence gaps due to lack of human resources. External ones are such as undeveloped exchange relationships, lack of experience, trust and reputation as well as lack of proof of business concept and reliance on attracting external resources in critical situations. However they have certain advantages in comparison to established enterprises such as high commitment, fast decision making, recognition and exploitation of opportunities, flat hierarchy, R&D efficiency, flexibility, direct customer orientation and adoption of innovation competence through tacit knowledge. [81]

When considering companies in the young end, the stage of the business is a clear differentiating factor. *Timmons & Al.* [112] present a five stage model of a venture life cycle with the focus on growth. The first, *R&D stage* (0 – 1.5 years), is the period when the entrepreneur or a team do the investigation and due diligence for their business idea, and business models can change often. Second is the *start-up stage* (1.5 – 3-4 years), which is the most perilous time and is characterized by the drive and energy. During this period the critical mass of people, market and financial results are established and investor and customer confidence is earned. The *high-growth stage* (3-4 – 10 years) is characterized by continually increasing rate of growth. New ventures exhibit 60 % failure rate during this stage, so this is the period when wheat gets separated from the chaff. Also delegation becomes necessary, and the original entrepreneur often needs to let go off ultimate power and control. Then, during the *maturity stage* (10 – 15 years) key issue is no longer survival but steady profitable growth. The last stage, *stability stage* (15 years and over) is the period where the growth finally stabilizes. [112]

Kaplan & Al. [108] present another kind of stage model, which covers only the start-up phase of the enterprise and separates the related actions in more detail. This model covers roughly the first three stages of the model by Timmons & Al. First stage is then *conducting the opportunity analysis*, which includes innovating and creating the vision and evaluating of markets and competition. This is followed by the *stage of developing the plan and setting up the company*, where the focus is on preparing full business plan and related activities. The next step then is *acquiring financial partners and sources of funding*, which includes securing both early stage funding and growth funding. The following stage is then that of *determining the resources required and implementing the plan*, during which it is time to manage finances, determine value of licenses, patents and copyrights, develop business model further to maximize value retention and prepare the organization for growth. The last identified stage is then *scaling and harvesting the venture*, when it becomes relevant to discuss the options and alternatives for the next steps determining the nature of the venture (e.g. sell or merge, go public, form a strategic alliance). [108]

As it shows, different authors have presented varying ways to describe the ways SMEs are aligned according to the orientation and stage of their growth. Naturally such models are harsh generalizations, and in practice the development of starting firms hardly follows such a linear path. The theories can however help to understand the typical perspectives and needs of new and small enterprises and can be useful when comparing to more specific, empiric research on SME behavior in R&D projects.

3.4.3 Classification by innovation capabilities

This thesis reviews the engagement of SMEs into public-private partnership based R&D projects. From that perspective, the innovation capabilities of SMEs are an important factor to take into account. As remarked in Section 3.3 small and medium firms are in general capable of innovation and contribute largely in both innovation and technological development. This section explores further on the different types of SMEs according to their role in this by going through some previous studies on the topic. Table 4 presents a summary on the classifications according to the authors and theories discussed in this section. The review below starts with a brief overview on the well-established, largely referred literature with a more general perspective and then continues with a review on more specific studies on the topic.

Table 4: SME categorizations based on innovation capabilities

OECD [17] & Hytti [99]	Pavitt [105] / de Jong & Al. [100]	Tidd & Al. [20]	Wood [115]	Ortega-Agiles [116]	EURAB [117]	MAPEER SME [5]
R&D intensive firm: High R&D expenditure – sales ratio. R&D high intensity firm: 20 % of staff dedicated to R&D.	Supplier dominated: Suppliers as source of technology and innovation Production intensive: Scale intensive → process innovations, specialized suppliers → product innovation Science based: Exploit own R&D and public science to innovate	Superstars: Successfully grown small firms Specialized suppliers: Combine technologies to meet customer needs Supplier dominated: Suppliers as source of technology and innovation NTBFs: High-tech start-ups, options still open.	Product and process originators : Strong in all innovation Product originators : Strong product innovation Process originators : Strong process innovation Product and process imitators : Lack of novelty Incremental product and process imitators: Rely on “upgrades” Occasional imitators : Lack systematic innovation	Growing SMEs: High-risk, seeking for fast growth Niche producers: Low risk, low growth, high survivability Corporate laboratories: R&D gambling, high risk research R&D-based gazelles: High growth achieved, still risky	Basic SMEs: No or few R&D activities Technology adopting enterprises: Adapt existing technologies Leading technology users: Develop or combine technologies in innovative way Technology pioneers: Perform high-level, collaborative R&D	According to employees dedicated to RTD, annual RTD income and expenditures and jobs resulting from introducing innovation: Low RTD capacity group Low medium RTD capacity group Medium RTD capacity group Medium high RTD capacity group High RTD capacity group.

Tidd & Al [20] have presented some general characteristics of small innovating firms in comparison to large firms. They share similar objectives to develop and combine technological and other competencies to provide goods and services that satisfy customers better than alternatives which are difficult to imitate. Typical organizational strengths of

small innovating firms are ease of communication, speed of decision-making, degree of employee commitment and receptiveness to novelty – often there is no need for formal strategies of innovation management. Small innovating firms also share some technological weaknesses, such as specialized range of technological competencies, inability to develop and manage complex systems and inability to fund risky and long-term programmes. It is also noted, that the significance of innovation varies according to sectors, on some small firms are more important innovators than on others. [20] The analysis by Tidd & Al. has lot in common on what Volkmann [81] notes on young enterprises – this is likely since young firms also tend to be small. It should also be noted that Tidd & Al. [20] review specifically small firms, not SMEs.

The concept of *R&D intensity* is also useful when assessing innovation capabilities of firms. *OECD* [17] defines it simply as the ratio between R&D expenditures and sales. Another indicator of R&D intensity is the share of dedicated R&D staff by *Hytti* [99], who also mentions SME categorization based solely on this indicator. RTD high-intensive firms are firms that have more than 20 % of their staff dedicated to RTD. Such enterprises are typically very small (turnover below 2 million and less than 10 employees), but still have a specific innovation strategy and are likely to develop networks with research organizations. RTD low-intensive firms are then the ones with less than 20 % of staff dedicated to RTD. [99] There is also recent research indicating, that R&D intensity restricts the growth of high-tech SMEs at lower levels of R&D intensity, but stimulates their growth at higher levels, whereas for non-high-tech SMEs the R&D intensity is purely restricting [113]. Thus, when aiming for growth, increasing R&D intensity is not usually advisable [113].

Perhaps the most referred classification of innovating firms is from *Pavitt* [105]. In this taxonomy, companies are categorized in three clusters: 1) *Supplier dominated*, 2) *Production intensive* and 3) *Science based*. The clusters differ in their technological trajectories and their determinants, as well as other selected measures such as source of process technology, orientation to product or process innovation and intensity and direction of technological diversification. Pavitt's approach however focuses on sectoral differences and even though size is one of the measures considered, it is not emphasized. It is thus not very relevant or fruitful for this particular study, but since Pavitt's work has been influential to later studies, it's necessary to acknowledge. Briefly summarizing, supplier dominated enterprises rely on their suppliers as sources of technology and do mostly process innovation, whereas production intensive enterprises rely also to R&D and are further divided into scale intensive firms (performing process innovation) and specialized suppliers (performing product innovation, are mostly small). The last cluster, science based enterprises, are the ones that exploit efficiently both own R&D and public science and are capable of both product and process innovation. It should be noted however, that this taxonomy only categorizes innovating enterprises, not the not-innovating types. [105]

One of the taxonomies derived from Pavitt's [105] is presented by *Tidd & Al.* [20]. In this study four categories of small, innovating firms are listed according to their stage, orientation and successfulness. *Superstars* are small firms that made it big. They exploited successfully a major invention or technological trajectory. The main challenges on the way are related to transition of control from the original innovator or innovation. These firms naturally no longer qualify as SMEs. The enterprises that remained smaller are either *specialized suppliers* or *supplier dominated firms*. The former are typically offering producer goods and their advantage lies in combining technologies to meet users' needs. Even though they perform little formal R&D, they are a major source of innovation, which is usually made by design and production staff. The strategy of specialized suppliers aims typically to link advanced users and pervasive technologies. Most small firms fall however

in to the category of supplier dominated firms, which rely on their suppliers as their source of new technology and innovation. They then adapt and integrate these technologies to gain competitive edge and their technology strategy aims to exploit new opportunities in design, distribution and coordination (in other words, process innovation). The remaining cluster, the *new technology based firms* (NTBFs) consists of start-ups typically doing business in the fields of in electronics, biotechnology or software. They have either product development in fast-moving specialized area or privatization of academic research as their source of technological advantage. NTBFs face the strategic question of whether to strive to become a superstar or to develop into specialized supplier. [20] It is then the growth orientation that determines which path the company takes. As it can be seen, two of the categories specified by Tidd & Al. [20] are directly derived from Pavitt's [105] taxonomy.

Another taxonomy further developed on the Pavitt's [105] work is presented by *de Jong & Al.* [100]. Their study is based on study on Dutch businesses with less than 100 employees (thus different from EU definition of SME), and ends up with cluster definition close to the one defined by Pavitt [105]. Three of the four presented clusters are directly from the earlier study: *Supplier dominated firms*, *specialized suppliers* and *science-based firms*. The fourth cluster is revised from production intensive to *resource intensive*. The similarity supports the idea that Pavitt's taxonomy is eligible as a basis in categorizing also small businesses. What *de Jong & Al.* [100] add to Pavitt's taxonomy are the more detailed analyses on innovation input and output intensity, management attitude towards innovation and tendencies to external collaboration. Science based cluster is the most innovative group of small businesses, which also have the most positive management attitude and are most prone to participate in innovation collaboration. The managerial attitude shows in formal innovation strategies and dedicating personnel to innovation activities. Open innovation is promoted in these firms, which also tend to be on the larger end of the size continuum. Surprisingly, the resource intensive firms dedicate most monetary resources in innovation activities, but don't have dedicated personnel or formal strategies and don't typically participate in external innovation collaboration. Supplier dominated firms lack managerial interest in innovation, as well as external orientation or and dedicated innovation resources. Specialized suppliers have medium innovation input and output intensity and some managerial orientation towards innovation, as well as some specialized personnel. They do frequent external innovation collaboration, but it has closed nature and is typically done only with customers. In the categorization some typical sectors of different clusters are mentioned, but it is added that all sectors and industries exhibit all of the clusters. [100] All in all, this taxonomy which combines Pavitt's [105] established categorization with SME focus and more up to date industry insight provides a highly useful model of innovating small and medium businesses to be used in policy design.

A one more taxonomy developed from Pavitt's [105] model is the one developed by *Evangelista* [114]. It reviews only service sector and divides the companies according to two dimensions: innovative intensity (relevance of R&D and design to innovation) and types of external sources of innovation. With such dimensions it arrives to four clusters: *science and technology based firms*, *technical consultancy firms*, *technology users* and *interactive and IT based firms* [114]. This taxonomy does not however differentiate companies according to their size [114], so it is not very relevant addition to the categorization list.

Naturally, there are SME classifications regarding their innovation capabilities that are not based in Pavitt's [105] work. One example is a cluster analysis by *Wood* [115] that is based on analyzing innovation output of British SMEs in the 90's. The average age of the firms in the study was 30 years [115], so they cannot be considered very growth oriented. In the analysis, six clusters of SME innovator types are presented. *Product and process origina-*

tors are capable of both novel product and process innovation and newly innovated products have a major role in their sales. Of all the clusters, the average firm size in product and process originators is the biggest (120.8 employees). These enterprises are also most active in participating informal or formal external innovation collaboration and large share (on average 18.4 %) of their staff consists of technical professionals, and also the share of R&D dedicated staff is high (16.2 %). *Product originators* are in many ways similar to the previous cluster, but lack the ability to do novel process innovation. The share of R&D professionals is also significantly lower (2.9 %), and they do lot less continuous R&D and external collaboration. *Process originators* are then companies that achieve novelty only in process innovations. Their characteristics are otherwise similar to product originators. *Product and process imitators* produce innovations both in products and processes but lack the novelty. This seems to be a strategic choice since reasonable amount of budget and human resources are devoted to R&D. *Incremental product and process imitators* rely on "upgraded" products (only incremental development) in their sales and supplier, customers and trade or professional journals as their external sources of innovation. The last cluster, *occasional imitators*, lacks the ability for systematic innovation totally. Typically no staff is dedicated to R&D and external collaboration is rare as well. As a result, no novel innovations and very few innovations altogether are introduced by these firms. [115] It should be noted that in this analysis, innovation is fairly loosely defined, since all business development is considered innovation of some sort.

In a working paper by the Institute for Prospective Technological Studies, *Ortega-Agiles & Al.* [116] provide yet another taxonomy of SMEs. As they claim that vast majority of SMEs do not perform R&D at all, the study covers only those SMEs defined as R&D intensive. R&D intensive SME is defined as one that bases its entire business on R&D activities. [116] Thus most of innovating SMEs fall outside of this category, but this in turn deepens the analysis of the most R&D active SMEs. In the taxonomy, four clusters are defined. *Growing SMEs* are high-risk companies with losses and high variability in profits. Operating losses are fairly low compared to R&D investments. Growth rates are still moderate, as the companies are at the stage prior to become gazelles (if they success). This cluster has high size variability in sizes and it covers all sectors, although some high-tech sectors are relatively overrepresented. *Niche producers* are more likely to niche market providers than research intensive. Their focus is on low risk strategies, which shows as higher survivability (this cluster has oldest average age) and lower growth rates. The companies are typically well established in their segments, which tend to be quite steady. The sectoral composition is mixed. *Corporate laboratories* are firms that are devoted to high-risk research, hoping to introduce profitable science-based innovations. Thus they are non-productive, rent seeking R&D gamblers with low or non-existent net sales. Typically young and small and operate in pharmaceutical or bio-tech sectors. They rely on external funding and usually have no problems in acquiring it from private sources. The fourth cluster, *R&D-based gazelles* are firms that achieved high growth and fast firm development through investments in R&D. Net sales and employment figures grow exponentially, but company behavior is still risky. The challenges lie in becoming and remaining large, since it requires high investments in physical capital. R&D gazelles are found in all sectors. [116]

European Research Advisory Board (EURAB) has made a proposal for a "*SME Research Stairway*" which also includes a classification of SMEs regarding their R&D capabilities [117]. This report identifies altogether five categories of companies. Vast majority (70%) of SMEs belong to so called *basic SMEs* which perform no or few R&D activities. *Technology adopting enterprises* do little better as they typically adapt existing technologies. Share of this category is 20 %. Less than 10 % of SMEs can be considered as *leading technol-*

ogy users, which develop or combine existing technologies on an innovative level. Finally, less than 3 % classify as *technology pioneers* which perform high level research activities and collaborate with universities and research institutes in R&D. [117] This classification has the benefit of also assessing the shares of different types of SMEs in the whole population. Besides the taxonomy, the Research Stairway lists targeted activation measures for each group. These are discussed later in Section 4.7.

A more recent European Union project *MAPEER SME* [5] charted the needs and requirements of SMEs in EU R&D&I projects, and also built a categorization of SMEs according to their RTD capacity. R&D capacity was defined by full-time employees dedicated to RTD, annual RTD income and expenditures and job positions created or sustained as a result of introducing new or substantially improved products or processes. According to this data, the firms were categorized in five groups from *low RTD capacity group* to *high RTD capacity group*, with *low medium*, *medium* and *high medium* groups in between. Typical low capacity firms are small and mature and operate in the manufacturing sector. Low medium group is similar, but are more active in participating collaborative R&D programmes. Medium RTD capacity group are also on average small and mature and typically from ICT sector. In high medium and high RTD capacity groups most of the companies are micro-sized and there are relatively more young SMEs among them. [5]

As the overview shows, different studies have made similar observations on SMEs. When discussing innovation capabilities, a clear indicator seems to be the source or driver of the innovation. For the less-innovative SMEs, the existing value network – supplier and client contacts – have a strong role in guiding the innovation. The more innovative SMEs are then capable of exploiting emerging technologies and to bring more radical innovations to the market. There are however some differences in the various classifications too, both in the taxonomy focuses and in their conclusions.

3.4.4 Classification by participation in R&D collaboration

Continuing the classification by innovation capabilities, the SMEs can be categorized as well according to their performance in actual R&D collaboration. This section provides an overview on studies made from this perspective. The overview relies on four studies, which are presented and summarized in Table 5. There is some overlap between these sources and the ones reviewed in the previous section, but in general this part is complementary. After looking into how SMEs differ in their innovation capabilities, it is naturally to continue to see how they are different in their approach to participation in public research projects and programmes.

Perhaps the simplest way to classify firms according to their R&D collaboration is to categorize whether they participate or not. Since the R&D collaboration in European Union Framework Programmes is based on projects, the classification has to have some defined time frame. In the mentioned *MAPEER SME* project [5] the definition of RTD programme active firm was a company that has participated at least one RTD programme in the last five years. Hytti [99] uses this classification and lists some characteristics of Finnish RTD programme active and inactive SMEs in the national *MAPEER SME* report for Finland. The RTD inactive firms typically serve on local or national markets and are prone to using mature technologies, whereas the RTD active firms are typically active on European markets and have both higher RTD capacity and RTD related income. They are also more likely to have more often a specific innovation strategy, and are more prone to developing breakthrough products. Not surprisingly they are also more likely to engage in in-

formal networking with research organizations. The RTD active firms also have higher absorptive capacity regarding EU R&D programmes. Thus, the previous experience makes them more ready to participate again. However, it is concluded that earlier participation is not an especially good factor for differentiating SMEs. [99]

Table 5: SME categorization according to participation in collaborative R&D projects

MAPEER SME [5]	Hagedoorn [25] / Luukkonen [24]	SMEpact [32]
RTD programme active firm: RTD programme participation during last 5 years. Typically active in European markets.	Technology orientation: Aim to knowledge base of the company, to train R&D personnel, to monitor the field and build contacts on academia. Market orientation: Developing new products or processes, learning about new markets and creating business alliances.	Technology developers: Strategic innovators and exploitation seekers. Technology networkers: Experienced technology networkers, curious and helpful and free riders.

Another simple way of classifying SMEs according to their participation in R&D was presented by *Hagedoorn* [25] and later used by *Luukkonen* [24]. They present a division based on motives of participation with the two options being *technology orientation* and *market orientation*. The research by Luukkonen was based on Finland-based companies that participated the 4th Framework Programme, and covered enterprises of all sizes, not just SMEs. However, the classification can be applied only to SMEs as well. It seems that companies have typically either of them, but not both. Technology oriented participation has the aim to learn from partners, to enhance knowledge base of the company, to train R&D personnel, to monitor the development of the field and to maintain or build contacts with university or research institute partners. For market oriented companies the motivation lies in developing new products or processes, learning about new markets and creating business alliances for marketing purposes later on. SMEs are more likely to be market than technology oriented [24, 25]. On one hand Hagedoorn notes that technology related motives are dominant in high-technology sectors [25]. On the other hand, the study by Luukkonen found that companies with high R&D intensity tend to be market oriented whereas companies with low R&D intensity tend to be technology oriented (this is for all companies, not just SMEs). Possible explanation is that low R&D intensity enterprises have shorter timelines in their market related research and rely on their customers in it. The EU Framework Programme structure gives a possibility to engage in a more risky, long-term research for them [24].

The EU project *SMEpact* [32] delivered a study on SMEs that participated in the Fifth and Sixth Framework Programmes of the European Union. In a cluster analysis, two

main groups with altogether six subgroups of SMEs were found, and the taxonomy was mainly based on two dimensions: alignment and involvement. The main division line was observed between the orientation towards development or networking. Thus, the main categories were defined as *technology developers* and *technology networkers*. [32]

The group of technology developers consists of three types of enterprises. *Strategic innovators* (21.7 % of all studied companies) are both highly aligned and highly involved in the projects. They tend to be of micro or small size and relatively mature (over 10 years) companies. These firms consider FP projects critical or important as they offer them source of funding and human resources that enable the SMEs to do things they would otherwise not be capable of. These SMEs often play important role in the projects and make substantial contribution in both the R&D work and result exploitation and seem to benefit from the participation also when measured by economic performance. *Exploitation seekers* (12.5 % of the studied companies) demonstrate high involvement as well, but less alignment than the previous group. They attend the projects with the explicit hope of exploitation of results. These firms are also usually micro or small as well, but compared to Strategic innovators they show relatively lower R&D intensity. Somewhat paradoxically these SMEs tend to have high impact on the projects, but the impacts on the SMEs are often limited. Third group of technology developers is called *Translators* (17.5 % of all firms studied). These companies often participate after they have been asked to join the project in order to play the role of the translator between research and market. Doing this they show low alignment and medium involvement. They usually have previous experience from participation and are adept at introducing new technologies to the market and somewhat R&D intensive. They consider projects important but not critical to them and tend to have significant impact on the projects, but the impacts on the SMEs have mixed results. [32]

The second main group identified in the SMEpact study [32], Technology Networkers, consists also of three subgroups. *Experienced technology networkers* (20 % of all studied companies) join Framework Programmes for the purpose of technology intelligence and network development. Level of alignment is medium and the level of involvement is low. They usually have extensive experience on EU projects and solid reputation as well. The typical roles in projects are technology providers or advisors, but they tend to act in the periphery of the projects. Experienced technology networkers tend to demonstrate R&D intensity and mature age (over eight years). These firms have mixed results considering the impact of the firm to the project, and the impacts on the firm are clearly limited to networking with no or low business impact. The group of *Curious and helpful* (23.3 % of the studied companies) consists of good networkers that joined projects for curiosity and willingness to help, even if FP projects were not highly aligned with their strategies. The level of R&D intensity is typically low and the typical firm age is over 10 years. These companies regard participation as positive experience that develops R&D capabilities as well as cross-cultural and interdisciplinary skills. However the business impact remains low, and so does the impact on the projects. Curious and helpful cluster demonstrates low alignment and medium involvement. The final group, *Free riders* (5 % share) are firms that joined projects when asked to 'fill the quota'. They are typically found through existing networks and are usually mature and medium-sized companies. Thus, they are able to allocate resources to projects that are not of direct strategic interest for the company. The motivation of participation lies in funding and building social capital. Both the level of alignment and involvement remain low, and so do the impacts on both the company and the project. [32]

Although these taxonomies based on SME participation in R&D projects bring an interesting viewpoint in SME classification, it should be noticed the same company can act differently in different projects. A free rider of one project can be strategically aligned in

another one, and choice between market and technology orientation can be made for each project separately. This type of classification thus differs from the previous ones in this way. Having said that, the literature shows that firms with certain characteristics tend to act certain way, and these connections should be addressed when designing policies.

3.5 Chapter summary

Entrepreneurship is the force that keeps the economy developing, and small and medium enterprises are the main actors materializing it. These SMEs comprise huge majority of all the private businesses. Although they're underrepresented in productivity and employment figures, they have an important role in renewing the markets. With little bureaucracy and organizational inertia SMEs bring dynamism into the economy and have a major role in introducing innovations, especially in product and radical innovations.

Defining SMEs is ultimately arbitrary and the upper size limit differs according to the defining party. In this study, the definition by the European Union is used, which sets the limit lower than in some other regions. SMEs as a group of enterprises can naturally be further grouped. Sub-categorizing by size in micro, small and medium enterprises is straightforward, as well as categorizing by the industry sectors. More open to interpretation are the taxonomies based on behavior and multiple factors. Clusters based on orientations towards growth, innovation and R&D collaboration provide helpful concepts for the analysis in the rest of the study.

4 SMEs in the EU funded research and development projects

The previous two chapters provided a general introduction to public-private R&D collaboration and small and medium enterprises. This chapter covers the literature regarding the combination of these two topics with the focus on European Union; it discusses how and why SMEs participate in public-private R&D collaboration. First, continuing from Chapter 2, the current mechanisms and participation processes are described in more detail and from the perspective of an SME. The participation statistics are also reviewed. The idea is to describe the current situation, and then continue to the perceived benefits, problems and other aspects of participation. Finally, policy recommendations from previous reports and studies are summarized. All in all, this chapter focuses on literature that builds on empiric research – theoretical frameworks or concepts are not revisited.

4.1 *SME engagement and participation in FP7*

The structures of the EU Framework programmes were described in Section 2.3 in general and in Section 1.4 for the particular case of FI-PPP. In the projects SMEs are only one of the named stakeholders which include different private and public actors. However, perhaps related to the shifts in economics thinking, the SME sector has received growing attention in the development plans [1, 118].

SME engagement has been encouraged in various ways. The European Commission has set target funding share of 15 % to go to SMEs in the Cooperation part of FP7 [118], and at the moment this has been nearly fulfilled with 14.4 % share [72]. There is strong variation in success between different themes with the share of SME funding ranging from 4.4 % (*Socio-economic Sciences and Humanities* theme) to 22.7 % (*Nanosciences, nanotechnologies, materials & new production technologies* theme) [72]. In the ICT theme the share is the same as the average [72]. Besides the funding reports, the commission has been interested in the outcomes and characteristics of participation. These have been studied and reported via multiple processes and projects examining the current and previous Framework Programmes [5, 32, 72, 117, 119]. The most relevant of these studies are the SMEpact [32] which provides an impact assessment of the SME participation in Fifth and Sixth Framework Programmes and MAPEER SME (stands for "*Making Progress and Economic enhancement a Reality for SMEs*") [5] which has covered the needs and requirements of the European SME sector on European and national level regarding R&D collaboration. Thus, SMEpact focuses on enterprises that have participated, whereas MAPEER SME has a more broad view [5, 32]. Results from these studies are referred widely in this chapter.

Besides measures to encourage SMEs to participate in the R&D projects, two special schemes have been launched within the FP7. As mentioned, SMEs vary greatly in their ability to innovate and devote resources to research and development. With a special focus to the SMEs with limited R&D capabilities [120], *Research for SMEs* [121] and *Research for SME associations* [122] have been introduced. The idea of these schemes is to provide SMEs a possibility to outsource R&D projects they are unable to invest in themselves to research organizations, such as universities [121]. Thus, in these projects the relationship with the organizations is more like customer-buyer [121] than truly collaborative. The structure is same in both of the schemes, the latter just enables SMEs of same industry or segment to participate as a group [122]. Research for SMES and Research for SME associa-

tions are built in bottom-up manner, so that projects may address any research topic across the field of science and technology [121, 122]. These schemes are implemented under the Capacities programme of the FP7 [72], so they are separate from the thematically oriented projects in the Cooperation programme, which covers majority of collaborative R&D activity. Naturally these schemes are not applicable for short-term technological problems, but meant to support the SMEs in acquiring technological knowledge and skills that can be put to use in medium- or long-term business development [121].

The European Commission tracks the rates and statistics of the SME participation regularly. At the time of writing of this thesis, the most recent publication is from the spring of 2011, meaning that the possible impact of many of the measures meant to strengthen SME participation are not yet visible in it. The share of SME funding is forecasted to grow to 15.7 %, thus ultimately reaching the target of 15 %. On average, a project consortium in Cooperation programme has 1.9 SMEs participants, and altogether 6,544 SMEs have participated. Average SME in the programme participates 1.4 projects, so there have been around 4,700 individual SMEs taking part. 10.5 % of all the projects are coordinated by an SME. Average EU contribution to an SME in a project is 272,000 euros. The schemes providing research for SMEs and SME associations have had 2,432 SME participations with the average EU contribution per participant being 184,500 euros. Although the share of funding is approaching the set target, the SMEs are underfunded in relation to their participation. In the Cooperation programme 16.6 % of all project participants are SMEs, compared to the 14.4 % share of funding. The average EU project contribution to an SME is several tens of thousands of euros lower compared to the average in general. [72]

The degree of SMEs participating in EU funded R&D projects compared to all SMEs is low. In the EU-15 countries 46 of 100,000 SMEs have participated in FP7 and in EU-12 the figure is 24, the average for the whole EU thus being around 42. The degree varies between countries greatly. In the countries with the most active SMEs (Ireland, Estonia and Cyprus) the ratio of participation is multiple times higher than the average. In Finland, an SME is almost twice as likely to participate as the average, with the degree being 75 participants among 100,000 SMEs. [72]

4.1.1 Programmes outside FP7

As mentioned in Chapter 2, the SME targeted innovation support activities are not restricted to FP7. Although FP7 provides the instruments to support R&D projects, encouraging innovation is in central role in many other programmes too, thus resulting in some overlapping at least in conceptual sense.

The Competitiveness and Innovation Framework Programme (CIP) is set to support innovation activities, improve access to finance and deliver business support services in the regions with the SMEs as the main target and special focus on eco-innovation [37]. The CIP is further divided into three operational programmes which cover different general and thematic support actions [37]. Thus CIP does not provide R&D project funding, but projects an activities to improve conditions for SME development and innovation instead. An example of an activity financed through CIP is the formation and upkeep of the Enterprise Europe Network, an organization that brings together business support organizations from different regions and provides services for enterprises interested in growth and internationalization [123]. An example of the services would be guidance for SMEs in FP7 participation [123]. CIP runs from 2007 to 2013, after which it will be followed by

Programme for the Competitiveness of enterprises and SMEs (COSME) running from 2014 to 2020 [124]. COSME follows the themes and targets set for the CIP.

Another programme aimed to SMES is Eurostars, a joint initiative with FP7 and the EUREKA network. Eurostars is targeted to research-intensive SMEs (participants should invest at least 10 % of their annual turnover to research) and funds international, collaborative innovation projects. The projects must have at least two participant organizations from two different countries and are limited to civilian markets. The funding is project-based and is granted according to applications on continuous basis. The programme runs from 2008 to 2013 with a total budget of 400 million euro, a quarter of which is coming from FP7. Thus the budget is smaller by an order of magnitude compared to the targeted SME-earmarked funding of FP7, but Eurostars still offers respectable options for SMEs that qualify as possible participants. [126]

Besides the support in programme format, the more established structures within the EU also provide support for SMEs. Structural Funds and Cohesion Fund support SME development especially in the less developed regions and low-income member states, with special emphasis on environmental protection [125]. These funds, although coming from the EU, are typically paid via national or regional authorities [125]. European Investment Bank (EIB) encourages banks to support SMEs, and the European Investment Fund has set a special Joint European Resources for Micro to Medium Enterprises (JEREMIE) initiative to increase SME financing options [125, 127].

4.2 *The participation process from the SME perspective*

In order to state recommendations for development, it is necessary to understand the process of participation as it currently works. The structure of FP7 projects was described earlier in Section 2.3.1 in general, and the SME perspective is covered below. This part discusses the topic from the FP7 perspective.

In general, an SME can participate in a project as a participant, coordinator or subcontractor. There are also experts involved in process, whom can be found from the SME sector as well. The general cycle of a project is shown in Figure 5. The process can be divided into five stages; proposal, evaluation, negotiation, project implementation and follow-up (which includes use of results and possible audit) [41, 128].

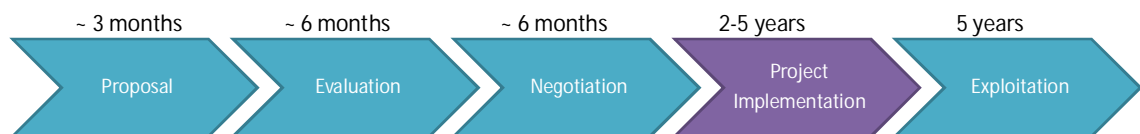


Figure 5: The phases of a project (modified from [41] and [128])

In the proposal phase a project is proposed, based on an open call for proposals. Calls are based on established work programmes (e.g. ICT work programme under Cooperation part of FP7) and published by the European Commission within the Participant Portal website, which is accessible to any actor by registration [129, 130]. The relevant details of the call are described in a call fiche. The fiche contains the essentials about the call, such as deadlines for application, budget, funding schemes and the topics called for (typically referring to some work programme). It also defines the eligibility requirements and

the evaluation procedures, most of which come from higher level (e.g. are defined within the Cooperation programme etc.) but might be specified for each call. Basically eligibility requires that the proposal is sent in time, is complete, involves minimum number of participants and is clearly related to the topic and the right funding scheme, but also more specific criteria can be set, such as minimum share of SMEs in consortium [128]. Proposals describe planned research and development activities, their cost and the participants and consist of two parts: requested administrative forms and scientific proposal description [128, 131]. In general, the coordinator of the project is responsible for the overall planning of the proposal, as well as building up the consortium [131].

After a proposal has been submitted, it is evaluated. The evaluation process is presented in a flowchart in Figure 6. First step is naturally the eligibility check, after which the proposal will be evaluated by experts assigned by the Commission. Experts represent academic and industrial expertise as well as users, but act independently and do not represent any organization or actor but themselves. The eligibility of the experts is also ensured. The experts will evaluate the proposals both individually and as a group according to pre-set evaluation criteria. The criteria may vary according to funding scheme, but generally *scientific and/or technological excellence, quality and efficiency of implementation and management and the potential impact through the development, dissemination and use of project results* are the three aspects of evaluation [128, 131]. In a two-stage application process, the implementation part is not evaluated in the first stage [128]. An additional ethical review is done if the evaluators see it as necessary. Based on the evaluation scores, the Commission ranks the proposals and draws up the final list of possibly funded proposals [131]. The success statistics of proposals vary between the programmes, but the overall success rate for proposals from 2007 to 2010 was 21.1 % [132].

Should the proposal be passed in the evaluation, it then continues to the negotiation phase. Negotiations are aimed to conclude in a Grant Agreement between the applicants and the Commission. The process includes both scientific and financial negotiations, and at this phase all the participants are required to register as they are validated as legal entities. The phase might also include financial capacity check to confirm the participant capability and consultation of the programme committee to ensure that the project is aligned with the call goals. The coordinator is responsible for representing the applicants in the negotiations. [133]

After Grant Agreement has been completed, the project may start, arriving to the implementation phase. First, pre-financing is paid to provide beneficiaries enough cash flow to carry out the first part of the project [133]. During the course of the project, there are certain reporting requirements. Deliverables defined in the Grant Agreement need to be submitted according to a dealt timeline – such deliverables can be for example analyses, plans or physical implementations [134]. Adding to the deliverables, periodic reports have to be submitted at the end of each reporting period. These reports cover summary of progress and use of resources and financial statement [135]. The Commission can also audit the project while it's still ongoing and decide to suspend the project pending corrective actions or even terminate the Grant Agreement [133].

At the end of the project a final report has to be delivered, which contains summary of results, a dissemination plan and report considering the wider societal impacts of the project [135]. After the project has ended, the beneficiaries are supposed to exploit the results according to IPR arrangements set by the Grant Agreement and the possible Consortium Agreement [133]. One of the requirements of the funding actually is that the beneficiaries should ensure that the results are used by themselves or some other party either for research or for commercial exploitation purposes [136].

The general description of the participation process also sets the framework for SME participation. As a coordinator, an SME faces quite high administrative workload. As a beneficiary the comprehensive reporting is still necessary, but the interface towards the Commission needs not to be taken care of. As a subcontractor the situation is totally different, as the activities are not tied to the Grant and Consortium Agreements but separate deals instead. But then there is no guarantee for the benefits of co-operation or IPR, as the situation is more a typical customer-supplier relationship instead of collaborative R&D undertaking. It should be noted that the current rules rule out the possibility to participate as a group or cluster without setting up a legal entity. Outside the projects, people from SMEs can act as experts in evaluation and review processes.

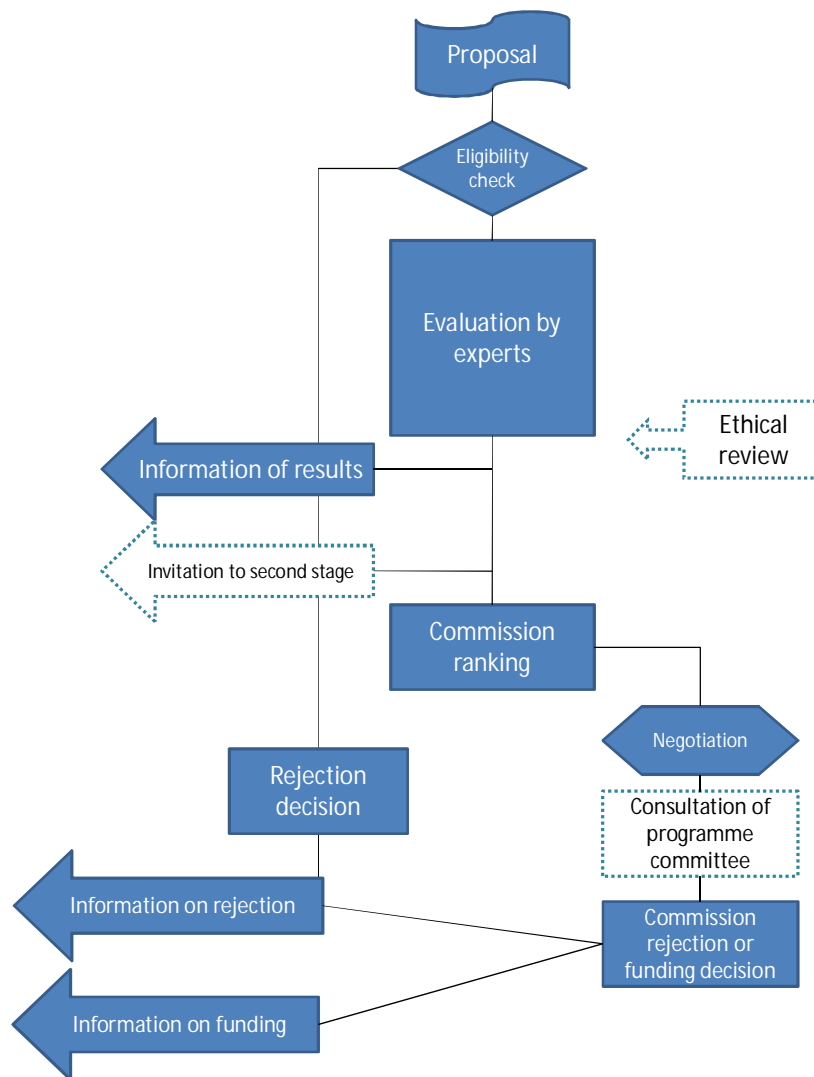


Figure 6: Evaluation process. The actions with dashed outlines are optional, and depend on the exact programme and project (modified from [131])

In the case that SME grows larger than the definition permits, it is entitled for the SME status related benefits for two years within a project. For the third consecutive year of

being larger it is no longer considered as an SME, but this is not applied retrospectively. Regressing from large company status into SME during a project does not grant SME benefits for the company. [137]

One of the most important aspects of participation is the point of entry in the process. There are in general two ways; either the SME scans independently the calls and looks for opportunities, or then it is asked to join in a consortium. Several projects have been undertaken to enhance the matching SMEs with other stakeholders. For example in health and aerospace sectors web portals have been set up where research organizations can search for SME partners [138, 139]. The network of National Contact Points (NCP) is supposed to be the main support mechanism for SMEs to get information on participation possibilities [140].

4.3 Motives

The motives of private enterprise participation in general were discussed earlier in Chapter 2, and for SMEs they were described in more detail above in Section 3.4.4 as the different types of participant SMEs were categorized. SME participation is either market or technology oriented [24], meaning that they emphasize either direct or indirect business benefits. Funding provided by the EU is a means to an end, not motivating in itself.

Behind the two orientations lie the more practical motives to participate. According to the SMEpact [32] study, SMEs view involvement in EU funded projects as an opportunity to look into not critical but promising issues. Immediate commercial outcomes or exploitation are not sought, but instead the aim is to explore promising application and know-how [32]. Also the older study by Luukkonen [24] notes that SMEs favor pre-competitive projects. Thus it seems that no matter the orientation, immediately exploitable commercial results are not sought for.

SMEs also do parallel in-house projects when participation in public projects, so that the confidential part of work is done in-house, and the less confidential work is done via collaborative project [24]. Some SMEs (*Technology Developers*, see 3.4.4) primarily participate FP project to gain access to key resources enabling them to develop specific technologies [32]. The motivation can then also be that EU funding supports or enables attached research and development activities that are critical to the company.

For the other consortia beneficiaries there is a quite straightforward incentive motivating collaboration with SMEs. Involving SMEs in a project is essential for it to be approved in the first place [128]. SMEs are also recognized as important link between industry and science [32]. Different motives of different actors naturally rise from the expected benefits, which are then either validated or not as the project proceeds. The benefits perceived in previous studies are discussed next.

4.4 Benefits

This whole study aims to find ways to improve SME engagement. The justification can be derived from the economic significance of these companies, but it is worth studying whether and what other benefits increased SME participation yields. Both the benefits for the SMEs and the benefits for the projects are important to notice.

According to SMEpact study [32] SMEs tend to assess the net impact of their participation from a technological and R&D perspective rather than from direct economic and

business perspective, and this is also how positive effects are perceived. Still, almost half of the SMEs experience positive economic impact arising from participation in Framework Programme projects. The more critical the project in question was, the greater the economic impact. Most SMEs also experienced boost to their R&D and innovation capabilities, and the improvement was sustained at least for few years. [32].

The MAPEER SME report [5], which describes SME participation benefits not for EU funded but national and regional programmes, lists *knowledge benefits*, *networking benefits* and *reputation benefits* as the most important benefits perceived by SMEs [5]. Knowledge benefits include enhanced in-house competences in R&D performance and management as well as access to complementary expertise [5]. Networking benefits include formation of new partnerships and networks and improved commercial and R&D linkages [5]. Reputation benefits are enhanced reputation and image [5]. The benefits pronounced by both the high and low RTD capacity groups (see 3.4.3 for group descriptions) were similar [5]. In comparison, *economic* and *internationalization* benefits were not ranked as high [5] – for the latter this is not surprising, considering that the study was about national and regional programmes. It should be also noted, that economic benefits were appreciated quite high (generally over three in five-figure scale) in absolute sense, although they were less appreciated compared to the mentioned high-ranking benefits [5]. There were some regional differences in emphasis, as firms from new member states tend to appreciate economic benefits more compared to the rest of the states, where networking benefits are appreciated instead [5].

The MAPEER SME study was compiled of national level studies. The results of the Finnish study by Hytti [99] are quite aligned with the European level compendium. It states enhanced knowledge and competence and other non-tangible knowledge and reputation benefits as the most important benefits for the SMEs active in participation [99]. At least in this sense the Finnish SME sector can be seen to represent the EU at large.

Switching then to the project perspective, according to SMEpact [32] the benefits of SME involvement are clear. SME participation has had positive impacts on Framework Programme projects. Both the proposal and the execution stages of projects are improved by involving SMEs. SMEs bring in complementary, specific and otherwise unique assets. According to the SMEs it is their technical skills and expertise that make them valuable for the projects. Setting clear objectives enhances the benefits. When the objectives for the SME participant are specific and problem solving oriented, the SME involvement typically leads to very positive impact to the project outcomes. [32]

A study limited to energy theme of FP5 and FP6 also concluded that SME involvement is beneficial for the projects and the companies [141]. Both the SMEs and other stakeholders surveyed in the study perceived that SMEs had important role in improved technological development and that the results would not have been reached without the participation of the SMEs. SMEs also saw that they had helped successful project execution. SMEs also perceived beneficial impacts on themselves, especially the improved knowledge development and improved international cooperation and partnerships. [141]

Thus, according to these studies SME involvement is beneficial not only from the economic viewpoint, but also in smaller scale to the SMEs and the projects. Measures to improve SME engagement are then likely to be beneficial as well. However, the 'optimal level' of SME engagement is yet another thing, as the measures cannot be developed with only SMEs in mind. The Framework Programmes or EU R&D funding does not exist just to support SMEs.

4.5 Barriers and needs

As previously shown, participation in public-private R&D collaboration projects tends to be beneficial to SMEs – or at least perceived that way by the SMEs that have participated. Still, only a small portion of all SMEs apply to participate. The barriers to participation have been researched in various studies that are reviewed next. Just like the benefits, barriers can be viewed from both the project side and the enterprise side. The barriers, especially the internal barriers of the companies, then translate as needs to be addressed.

According to the MAPEER SME study [5] the dominant reasons for not participating in EU R&D programmes were basically so called *administrative barriers*. Such barriers include complex reporting requirements, bureaucratic or non-affordable application procedure and long time-to-contract and time-to-funding. Differing national programmes, *financial barriers* such as funding rates or unavailability of additional finance sources are not important barriers in EU funded R&D programmes. Only Southern European SMEs saw financial barriers important. Regarding to different sizes of SMEs, there were some differences in the perceived internal barriers. Medium size enterprises main internal barrier was that they did not see the need to participate, whereas micro sized enterprises emphasized the limited in-house knowledge on project management. Micro-sized also noted limited marketing/information about programmes as an important barrier. Still, administrative barriers were the ones perceived relevant by all the different types of SMEs. [5]

Another report [53] within the MAPEER SME project presents main barriers experienced especially by non-research performing SMEs. Such enterprises don't understand the benefits and possibilities of R&D and project participation and they lack internal resources fully devoted to R&D activities. These SMEs are also unaware of the different subsidy schemes offered, as the current dissemination and information activities do not reach them. This barrier is not limited only to practical communication, but also to the way of thinking. As long as R&D is considered as some specialized activity instead of core activity of an SME, the message is difficult to get through. [53]

Again the national level study by Hytti [99] is on the same track as the European level MAPEER SME reports. In the Finnish study a central barrier for R&D active SMEs is the lack of in-house funds and for the R&D inactive SMEs lack of access to information forms a barrier [99]. The administrative challenges in EU programmes are mentioned too, but financial barriers are not the important barrier they are in national programmes [99]. Also the SMEpact study notes bureaucracy as a central barrier. Initial documents required at the time of response, length of selection process, heaviness of the reporting and required audit of accounts are listed as examples of excessive administrative burden [32].

Although the requirement of sufficient in-house competence does not rise as central barrier, it has been discussed in academic literature [27]. In order to be successful for the company, publicly-funded R&D projects should only be a part in wider portfolio [24]. Another acknowledged issue hindering the possibilities to participate is the fact that collaborative R&D projects have low success rate in general, and that SMEs only have limited opportunities to fail compared to larger organizations [27]. This barrier is also lacking from the studies regarding EU funded R&D projects. Perhaps the reason is that as the SMEs do not seek direct market benefits from these projects, the actual success in results is not that critical either. The success is perhaps measured more in the technology and network gains.

As said, the needs arise from the perceived barriers and difficulties, and have been mapped in the same studies. Not surprisingly, the SMEs surveyed in the MAPEER SME project brought up the administrative needs such as simple application and reporting procedures and transparent proposal evaluation as important [5]. Also certain external needs

(e.g. adequate external assistance and guidance during the projects) were emphasized [5]. The micro- and small-sized and low capacity RTD SMEs in general tend to be in more need of guidance and also information about project opportunities [5].

According to Hytti [99] R&D intensive and low-intensive SMEs differ in their most important needs. The former emphasize high-funding rates and IPR protection, whereas the latter emphasize the need for easy access to information about the programmes, adequate marketing and external assistance and guidance during the project [99]. Thus, Hytti's study is in line with MAPEER SME study compendium, although there is slight nuance difference.

4.6 Other issues

The main problem relating SME participation in EU funded R&D projects is presumably the issue that too few SMEs participate. Otherwise many reports, statements and this thesis would not have been made. The engagement of SMEs does not reflect enough their economic significance.

However, according to the SMEpact [32] the number of SME participants is no longer the issue. Instead, impact, involvement and alignment need to be emphasized and improved [32]. The target funding rate neither seen as a problem, even though it was not reached in either FP5 or FP6 [32]. One perceived problem is that top-down approach leads to marginalization of SME into technology providers or minor development partners [32]. Thus, self-motivated involvement would need to be encouraged.

Another issue related to the SME engagement is the rising interest to bring together private investors with the innovative SMEs. Venture capitalists and business angels could support commercial exploitations of R&D project results, and the Framework Programme could provide investors with interesting enterprises that have gained experience and know-how by participating. At least two projects have been launched within FP7 two promote this issue. YMIR [142] and ICT VentureGate [143] were both set to bridge the gap between innovative SMEs and the private investors with focus on the ICT sector. These projects aim to achieve this by mapping the needs, and developing and providing services to match SMEs with investors [142, 143]. According to questionnaires by ICT VentureGate, both the SME and investor side are interested in increased cooperation and use of FP scheme to support investing and raising funds [144, 145]. Currently, the investors are not very familiar with the FP structure, and express also worries about the lack of market validation, lack of experienced teams and lack of business management skills [145].

4.7 Previous policy recommendations

The previous reports and studies on SME involvement have made several conclusions on how to improve the situation. These policy recommendations range from Framework programme level to practical project level, and also differ according to the target SME categories. Some of the suggestions have also been implemented, although typically on limited scale. The following presents a brief overview on the most relevant previous policy recommendations, mainly from the SMEpact and MAPEER SME projects.

All in all, myriad measures and ideas have been proposed to strengthen SME involvement in EU funded collaborative R&D projects and programmes. It could be summarized, that there are *administration, communication, commercialization* and *impact related* rec-

ommendations, that may or may not be limited to engaging SMEs, and then there are the recommendations of *measures to support SMEs in particular*. Some of the proposals are complementary; some are competitive in the way that they couldn't be implemented at the same time. The various measures mentioned in the reviewed literature are summarized under these categories in Table 6. Obviously, the lists within this table don't cover all of the various suggestions, but try to bring up the most frequently recommended and otherwise interesting ones. They are further discussed below.

Table 6: Summary on different types of previous policy recommendations [5, 29, 32, 53, 73, 99, 116, 117, 146, 147]

Administration	Communication	Commercialization	Impact related	SME specific
<ul style="list-style-type: none"> •Swifter selection process •Simplified participation rules •Simplified reporting requirements •Two-stage application process •Smaller consortia 	<ul style="list-style-type: none"> •Awareness campaigns •Promote exploitation focus •Proactive marketing •Targeted marketing •Utilize existing SME networks •Communicate success stories 	<ul style="list-style-type: none"> •Exploitation related targets and indicators •Knowledge brokers •Exploitation funds or bonuses •Cooperation with private investors •Procurement mechanism 	<ul style="list-style-type: none"> •Focus on pioneering SMEs •Focus on growth-oriented SMEs •Thematic approach to SME engagement •Promote open innovation 	<ul style="list-style-type: none"> •More advantageous funding rates •Separate micro, small and medium firms •SME specific calls •More open calls •Enable partial participation •Participation in groups or clusters

The main recommendation made by majority of studies and papers is to simplify the administrative processes or in other words "cutting red tape" [5, 32, 53, 99, 146, 147]. More specific measures related to this include swifter selection process, new methods for streamlining financial management (such as e-claims and allowing payments to individual partners) and shorter time to contract and payment [32] as well as simplifying participation rules and reporting and administrative requirements [5]. Two-staged application process is suggested as a specific measure suggested to lighten the application procedures and to decrease the loss of time and effort spent on unsuccessful proposals [32, 53, 117]. The first initial round would be used to select the most potential proposals, which would then be continued to full proposal stage. This approach has been implemented to some extent in FP7, and proposal process is either single or two staged depending on the call. Another way suggested to simplify project administration and improve efficiency is to decrease consortium sizes [53]. The problem lies in the evaluation criteria, which imposes artificially large consortia, which marginalizes SMEs [53].

Many of the papers suggest different measures to address different kinds of SMEs, naturally following the categorizations presented in Section 3.4. The SMEpact report suggests awareness campaigns for the types of SMEs currently don't find their way into the projects (Translators, Curious and Helpful and Technology Networkers), aiming to promote the exploitation focus [32]. This is backed the report by Hytti, which suggests more advantageous funding rates for active, high R&D intensive SMEs and awareness raising with proactive approach for inactive, low-intensive SMEs [99]. Also Ortega-Agiles et al. calls for tailored support for different enterprises, focusing on R&D intensive companies, but questions the need to support so called corporate laboratories at all [116]. According to MAPEER SME report, the recommendations for high and low R&D capacity SMEs are

similar but with different emphasis; the low capacity firms need more promotion and help with external funding [5]. It is also stated that SMEs of different sizes should not be treated equal, but micro, small and medium enterprises should have different participation and funding rules, with the idea that smaller companies would have higher reimbursement rates [53].

Perhaps the most comprehensive policy suggestion building on SME categorization is the “*SME Research Stairway*” proposed by the European Research Advisory Board (EURAB), presented in Figure 7 [117]. It lists different measures suitable for different SMEs according to their R&D capabilities. The measures include collaborative R&D projects, but the approach is not limited to them. The idea is that only the top performing R&D intensive SMEs should be taken into focus in collaborative R&D, and the rest of the enterprises should be supported with different, often unidirectional measures. It is stated that the R&D needs of vast majority of SMEs are based on very specific focus and have applied nature, and thus are better served with more short-run projects. Such SMEs can be empowered with competitions and contests and supported with information. EURAB has also emphasized the need to focus on growth-oriented SMEs. [117]

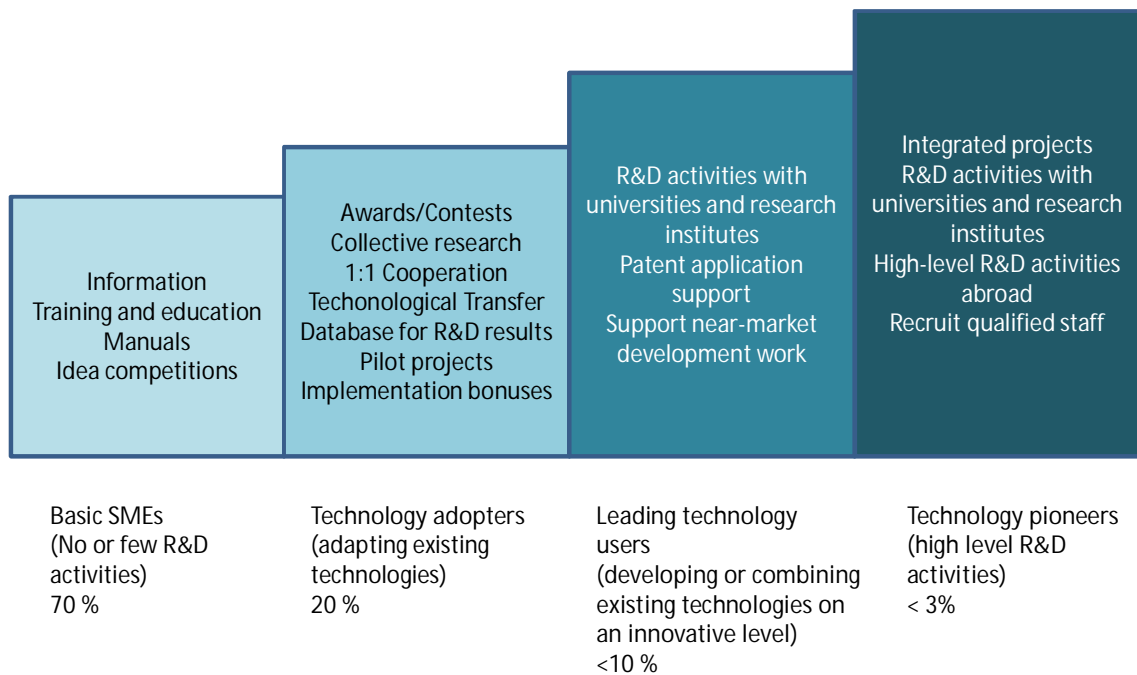


Figure 7: The SME Research Stairway by EURAB (modified from [117])

Another frequently occurring theme in policy recommendations is commercialization. SMEs are seen in key role in bridging the gap between knowledge creation and exploitation. To support this, several measures have been proposed. Within SMEpact it was suggested that the 15 % budgetary target would be complemented with targets related to exploitation activities within the projects or right after and the strategic objectives of FPs regarding exploitation need to be clarified [32]. Also the MAPEER SME project has backed this with suggestions that the objective of EU funded R&D should be moved from

"pure excellence" to *"excellence and exploitability of results-benefits for the community"* [53]. Exploitation funds and bonuses and industry-dedicated schemes should be used as new routes to exploitation [32, 53]. Utilization of specific knowledge brokers and innovation consultants has been suggested as well [99, 117]. It should be noted however, that too much emphasis on commercialization may cause bias to most commercially promising proposals, which might not need funding in the first place [29].

While some of the proposed SME engagement measures affect the whole nature of the programmes, some are very SME specific and suggested to be implemented parallel to existing practices. An example would be SME specific calls suggested by SMEpact project [32]. Such projects could be calls SME specific themes, shorter research horizon of up to 2 years with limited number of participants [32]. Budgets would be lower, but so would be the administrative requirements as well [32]. Another way to make calls more appealing to SMEs would be to increase the amount of open calls; too specific or closed topics are difficult for small companies to adapt to, as they typically have narrow line of businesses [53]. Enabling partial participation of SMEs is suggested as another way to enable more short-term participation, so that SMEs could join or be brought to the project at any time of the project lifetime. Especially allowing late-stage entry at the point when commercial exploitation is nearer could be interesting to the SMEs. This could be enabled by grant-vouchers dedicated to projects, as suggested by the MAPEER SME project [53]. To overcome barriers and problems of participation SME support could be increased before and during the projects by providing counseling, mentoring and assistance [147]. The necessity of understanding SME perspective has also been brought up [53]. Awareness of SME challenges and needs should be increased among evaluators, and 'client logic' towards SMEs should be adapted when developing the structures [32] [53]. Minimum participation of SMEs in large programmes such as ETPs, JTIs and PPPs should be secured [53].

As unawareness of opportunities was mentioned as a barrier, communication related recommendations are no surprise. In many occasions, promotion is suggested to be improved [5, 32, 99]. According to SMEpact marketing of programmes should be proactive, and existing SME networks should be utilized [32, 99]. Some dissemination activities should be targeted especially to SME sector and as mentioned earlier, the message could be differentiated according to different SMEs, and also be used to attract just the type of SMEs that are wanted [32, 53]. Successful SME participation cases should be utilized in marketing [53]. The need to improve SMEs access to information about networking opportunities has also been highlighted by the OECD [73].

On a more general level the SMEpact urges that SME involvement should be impact driven, emphasizing the outputs instead of inputs. The focus should be put on attracting the right kind of SMEs capable of producing high impact results not in the number of participants or share of funding [32]. Monitoring inputs, outputs and impact is naturally important part this approach [32]. Thematic or sectoral approach on SME engagement (with specific participation requirements and practices) is also emphasized as means to create projects and structures that reflect value chains and business models relevant to the SMEs [32, 116]. This could include promoting more cross-sectoral consortia (as example, involving multimedia SMEs in healthcare sector projects) [53]. Greater impact could also be pursued by focusing on growth oriented high impact SMEs [117].

Promoting open innovation and training programme managers and officers about innovation are also mentioned as recommended measures [53]. Bringing in some kind of procurement mechanism or other way to connect supply and demand sides is another idea to support both the exploitation and to raise SME interest [53]. Besides potential customers, another appealing stakeholder group for SMEs is private investors; facilitating connec-

tions between venture capital and SMEs has been proposed as recommended engagement measure [53]. Tax incentives and implementation awards are suggested to activate SMEs in general [5, 117].

Thus, numerous recommendations falling under various categories have been proposed. Another distinct feature in the previous literature is that there are two dimensions on SME involvement present. SME participation is seen to have both *intrinsic* and *instrumental* value. Intrinsic value means that comprehensive SME engagement is valuable as such; it should be done regardless of whether it helps to achieve the goals and targets set for the R&D activities. In this view, one purpose of the EU funded R&D is to develop the SME sector. In comparison, instrumental value means that SME engagement is justified only if and when it supports the R&D as a whole. Thus, SME engagement measures must be based on benefits it produces to the projects. The referred reports typically include elements of both views, but the balance between the two is an important ideological issue that ultimately directs what measures and how should be taken.

4.8 Chapter Summary

Involving small and medium enterprises into European Union funded R&D programmes has been discussed in various papers and statements, and there is solid intent to increase the engagement. Many measures projects related to researching SME needs, current barriers and problems have been undertaken. Recommendations have also led to implementations within and outside the Framework programme structure. FP7 (and FI-PPP funded under it) has fixed targets and high expectations on SME engagement.

SME participation in an FP7 project is determined by the same rules and guidelines as are the other stakeholders. The exact practicalities depend on the exact role, but the process starts from proposal stage, moves from evaluation and negotiation into implementation, which is followed by audit and use of results. SME have different motives to participate, but are in general either market or technology oriented. SMEs tend to benefit from participating, but benefits SMEs gain from participating are typically indirect instead of direct market gains. Also projects benefit from SME participation, as they bring insights and skills not possessed by the other participant groups. Still, there are various barriers and problems SMEs face. To improve the situation previous reports and projects have presented extensive amounts of recommendations, which are typically administration, commercialization, communication or impact related, or then planned to cater SME needs in particular.

5 Empiric study

In order to find answers to the research questions, literature review is only the first part of this study. It forms the basis for the empiric research part. The key concepts, background and the theme in general have been introduced in previous chapter, and this chapter describes how the empiric study builds on them. The methodology, methods and arrangements of the research are also presented.

5.1 Research methodology

The empiric part of this study is based on qualitative research, consisting of thematic interviews. In the following, the approach as well as the chosen methods and justifications behind them are presented.

Qualitative research typically addresses the topic as a whole, aiming to expose the structure of some entity or phenomenon and its intrinsic logic. Unlike statistical research, qualitative approach requires absoluteness; all observations that are considered reliable should fit in the interpretation. Statistical probabilities cannot be used as leads and large set of research subjects is not necessary, also making statistical argumentation unnecessary and impossible. [148] For this study, the qualitative approach was chosen because of the nature of the research questions. Instead of validating some exact hypothesis or producing statistical generalizations, the aim was to deepen the understanding on the complex issue and build useful theoretical frameworks for the future policy design.

There are two phases in the qualitative analysis: reduction of observations and making interpretations. In the reduction phase first step is to separate the relevant information from all the research material to form a set of relevant "raw observations". The next step is to combine these then into groups of observations. [148] In the interpretation phase these grouped material is then used to make conclusions in the form of frameworks or theoretical structures for example. [7, 148] This order of work presented also in Figure 8 was used also in this study, first gathering the observations, then grouping them according the main themes and then interpreting them to form conclusions. As part of the qualitative methodology, factual approach [148] was applied. This approach builds on the remark that the world and claims made about it are different things, which makes it relevant to assess the truthfulness of the responses. The aim is to reach for the practical, common opinion on what is the truth or reality. [148]

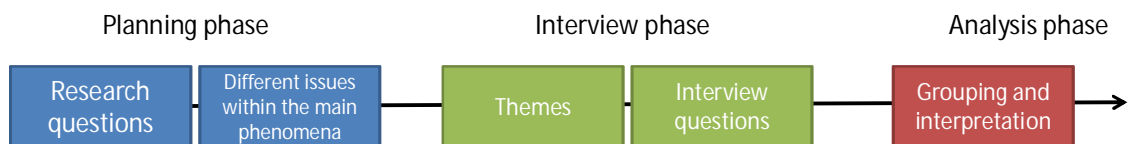


Figure 8: The process of the qualitative research interview in this study (modified from [7])

The vehicle chosen to conduct the qualitative research was semi-structured interview, and more accurately the so called thematic interview [7]. When the topic is known or assumed to result in complex answers that can lead to multiple directions, choosing inter-

views over more structured methods such as surveys can be reasoned. Also the need for clarification and deepening of understanding of the information related to the answers favors interviews as the method of collecting the observations. In a research interview, the task of the researcher doing the interview is to relay the thoughts, understanding, experiences and feelings of the interviewee, and the aim is to get reliable information on issues relevant to the research questions. Research interviews can be categorized according to how structured they are, and semi-structured interview is the intermediate option somewhere between structured interview with fixed questions and unstructured interview, where the idea is to facilitate a deep dialogue without pre-set course. [7]

Thematic interview focuses on themes instead of exact questions. It lacks the exact formulation and order of questions, but still follows the themes that are pre-set and gone through with each interviewee [7]. In this study, the questions were formulated in beforehand, but in the actual interviews they were modified and selected according to the situation and context. The emphasis was on the responses and comments provoked by the questions presented, not the exact 'yes or no' –answers, underlining that the interview was not strictly structured in nature.

The analysis phase as described in Figure 8 was conducted mainly through the methods of *counting* and *thematizing*, as described by Hirsjärvi et Al. [7]. Counting refers to counting certain issues or occasion from the interview material, in this study for example counting the positive and negative responses to the suggested measures. Such quantitative analysis is out of the scope of qualitative analysis according to some sources [148], but according to Hirsjärvi et Al. [7] counting can be useful in analyzing qualitative material. Thematizing refers to arranging the material according to themes manifested from the answers. In this case, the thematizing was done mainly according to the themes set for the interviews beforehand as could be expected [7], as can be seen in Chapter 6, which is written out mainly by these themes.

5.2 Interview arrangements

As described above, thematic, semi-structured interviews were used as the method to gather information. Although the schedule was relatively tight, a fair number of interviews were carried out. The following describes the practicalities and arrangements of the interviews.

All in all, sixteen interviews were done. The interviewees to be contacted were chosen so that they would represent different perspectives and best knowledge about current situation. All were also assumed to be somewhat aware on how EU funded R&D scheme works. The sixteen interviews represented various stakeholders: three SMEs, three organizations representing mainly SMEs, two large corporations, two organizations representing industries in general, three research institutes, two universities and one public technology and innovation funding agency. The full list of interviewees can be found in Appendix A. It should be noted, that the interviewees were chosen to represent their expertise and perspective, not the organizations, so the answers were considered as personal opinions if not stated otherwise.

The number of organizations presenting enterprises indirectly among the interviewees is high for two reasons. First, these organizations are supposed to be well aware of the perspective and situation of their member firms at large, and have typically higher level expertise on the public funding instruments than the individual firms do. Secondly, there are not so many SMEs in Finland with experience on EU funded collaborative R&D and

the companies that do not have this experience would have been difficult to address, as they would have had to be introduced to the theme first. This would have altered the research setting greatly. In the end, all the interviewees had experience on either national or EU level R&D funding. Resulting from the setting of the study and limited resources, there is certain Finnish bias as twelve of the sixteen interviewees were either Finnish or represented a Finnish company. When looking for potential interviewees, the sectors prominent within the FI-PPP, such as ICT and creative industries, were emphasized. For example forest based industries were excluded, as the actors on that field were assumed to not be very representative in general terms.

The interviewees were searched from the web, from the CORDIS database, the FI PPP programme and by asking from experts including the other interviewees. They were contacted by email explaining the study and its scope. The respondents were asked whether they thought they were capable and willing to participate and whether they knew someone more appropriate respondent. It was also explained, that the answers would be processed anonymously, except for the public list of all interviewees. From all the contacted persons, majority agreed to participate in an interview.

Twelve of interviews were conducted face-to-face and the rest by telephone. In case of face-to-face interviews, the interview was offered to be conducted either at the location of the organization or that other premises could be arranged. Most of the interviews were conducted at the office of the interviewee's organization. The interviews were originally designed to last for an hour, and this was roughly the average length, although the longest ones lasted around one and a half hours and the shortest ones only about a half an hour. The difference reflects mainly the difference in style of speech and willingness to discuss the issue in detail. One of the interviews was done together with a fellow thesis worker, the rest alone with only the interviewer and interviewee present. The interviews were recorded.

The questions used in the interviews can be found in Appendix B. The idea of the pre-set questions was to keep the focus on the issue and provide a pre-set structure for the interview. The structure was not however strictly followed, as often the interviewees moved from topic to another without such guidance. The questions were also picked in varying order, with the pursuit to support the interviewee in telling his or her story without jumping back and forth in topics. Not all the questions were presented to all the interviewees for time limitations and the irrelevancy depending on the background of the respondent. The interviewees were not hurried as long as they stuck on the topic in general; the objective was not to get answers to every single question but to understand the main points and perspective to the topic. New questions not present in the question set were also asked in continuation of interesting answers and insights.

The interview question format was developed during the course of the study according to the answers. Some new interesting questions were added based on the ideas presented on the interviews, and the structure of the interview was changed to better respond the typical approach of the interviewees. The latter change had no significant impact on the content of the interviews, but just made it technically easier to follow the structure. For five of the interviews a slightly different structure was used. The one interview done together with a colleague had to serve two separate studies, so the structure was merged with another set of questions. Another one was arranged on a very fast schedule and had stricter time limitation, so the question set was adapted to the situation accordingly. Finally, the three interviews conducted with stakeholders from within FI-PPP had a modified question structure, since the original idea was to do two separate rounds of interviews, with external and internal actors regarding FI-PPP. The two rounds were however merged into

one because of time constraints, and in practice the three interviews with FI-PPP stakeholders followed quite the same themes only with a slightly different structure compared to the other interviews.

The structure of the question set consisted of five parts; *background, SME engagement in general, different SMEs, policy recommendations* and *advices*. In the background part, the interviewees got to explain their previous experience and role in the topic. They were also presented the general background of the study and the FI-PPP. The idea was to chart the level of awareness and perspective to help steer the actual interview. In the general SME engagement part the interviewees were asked first about the topic in general with questions such as “*What is your general view on EU funded collaborative R&D?*” and “*Why should the SMEs be involved to publicly funded R&D projects, or should they?*”. These were then followed by more detailed questions about the main barriers, benefits and motives for SMEs to participate. This part was typically the longest one in the interviews.

Discussing different SMEs formed the second part, with questions related to current SME definition, possible categorizations and whether the engagement should be focused on certain types of SMEs instead of all. This part perhaps a bit surprisingly did not yield much input from the interviewees, and was usually discussed quite briefly. Continuing from it, the next part consisted of discussion about different possible measures to undertake in order to improve SME involvement. The list of suggested measures was compiled from literature and complemented with suggestions from completed interviews. The idea was to present the measures for the interviewee to comment on. This typically resulted in lively discussion instead of short comments, and helped to further deepen the views presented in the general part of the interview. After going through this part, the interviewees were asked whether they had more suggestions or something else they wanted to add before ending the interview. The final part consisted of meta-questions, where the interviewees were asked for interesting leads, such as articles or contacts, on the issue. They were also asked to evaluate how a study with such Finnish bias in data collection can be generalized on European level and what limitations could there be.

In retrospective, the interviews were conducted successfully. The assumptions on the awareness level were quite correct, although in couple of occasions the interviewees had to be explained how the EU funded collaborative R&D projects work in comparison to e.g. Tekes projects. In some cases it was also a bit unclear whether the respondents were talking about thematic programmes, Research for SMEs, CIP or structural funding, but at the latest during the analysis it was possible to reason this out by the context, if it was left unclear during the interview.

5.3 Limitations

Although the interviews cover wide amount of perspectives and seem to yield interesting results (see next chapter) there are obvious limitations to this study. Besides the mentioned Finnish bias, the small set compared broad scope and relying largely on ‘second hand’ sources – SME representatives instead of SMEs themselves – are perhaps the most relevant limitations.

Although sixteen interviews makes up fair amount of data for analysis and the answers seemed to converge to some extent, more interviews would have been better. This is especially true given the fact that the interviewees represented different perspectives, so that each type of stakeholder (e.g. academic, entrepreneur, lobbyist etc.) was represented by only a few interviewees. This means that the results are more of an overview instead of

detailed analysis. The broad scope of the study also underlines this. It should be noted however, that this limits only the depth of the study, not necessarily its validity, not to mention usefulness.

Relying on indirect sources is a two-edged sword. On one hand it enabled broader set of perspective and expertise with smaller set of interviews, but on the other hand it would be overstatement to claim that SME perspective was thoroughly explored in this study. Still, the chosen way of working enabled to include the – supposed – views of the SMEs that have not shown interest in participation and have not participated in publicly funded collaborative R&D activities. Achieving this by surveying such SMEs themselves would have required a very different approach, which would have not been possible with the scope and resources of this study.

Relying to the answers given by the interviewees, it can be assumed that the Finland-centric approach of this study doesn't prevent making generalizations for the European level. The characteristics of the Finnish innovation system (described in the literature review in Section 2.4 and confirmed by the interviewees) need however to be taken into account. Most relevant of these is the well-developed national R&D funding scheme, which probably decreases the need and interest towards European level project funding in Finland. This then resulted in challenges in finding experienced SMEs for the interviews.

Thus, this study has its obvious limitations, but can be still considered valid in its results. As any interesting study, this study brings about more questions than it answers. The suggestions for further research are discussed in more detail in Chapter 7, which concludes the study.

6 Results

After having described the arrangements of the empiric study in the previous chapter, this chapter presents the results and the analysis of the interviews. The structure of the analysis follows the structure of the themes in the interviews. The answers are processed anonymously, so individual interviews are not referred to in any case. For the full list of interviewees, see Appendix A.

6.1 SME engagement and collaborative R&D in general

When discussing about SME engagement in EU funded R&D projects, the main finding is that it is a complex issue, which has many perspectives, approaches and details that come in to play. First of all, SME engagement is not a separate topic, but closely linked to overall development and philosophy of the funding schemes. Secondly, SMEs are a heterogeneous bunch of companies. Thus, the answers were full of expressions such as "*It depends...*" or "*On one hand... on the other hand...*"

There are few underlying issues in the public R&D funding that affect the whole scheme. One is the balance between basic research and applied research. Although all respondents agreed that funding near-market development efforts is not appropriate as it distorts markets, there was no consensus on what actually counts as near-market and how much emphasis should be put on market orientation. Growing emphasis on basic research was seen to threaten exploitation possibilities and drive away enterprises (including SMEs). For example complementing the 15 % SME funding target with general enterprise funding target and ruling out any projects without realistic exploitation plans were suggested. The opposite view however was that basic research is the foundation for any innovations, especially fundamental and radical ones. Focusing too much on market aspects could lead to favoring moderate projects that are less risky but also have less impact, producing mainly incremental innovations. A thing everyone agreed on was that increasing the impact of the programmes is necessary.

Another central issue the question of whether such public support instruments should exist at all and what should be the central philosophy behind them. The EU R&D support scheme was seen as riddled with inefficiencies and exploitation, where the funding is used as welfare to participants instead of pursuing the set goals of the programmes. One point made was that the sense of ownership as well as customer perspective is largely missing. There is not enough accountability over end results. Still, such public funding was considered important both in order to address major global and European challenges, to help reach over the exploitation gap and to compensate the low levels of private investment in Europe. SBIR was often mentioned as example of a well-working support scheme.

It was also discussed whether indirect support such as fiscal incentives would be an alternative to direct project funding. Although fiscal incentives were mentioned as a good mechanism for companies with limited liquidity, such as start-ups, it was also noted that they wouldn't lead to the same scale of R&D funding and can't be guided or directed the same way as project-based funding. It is also challenging to determine universally what counts as R&D and not near-market product development. Many stated that fiscal support and project funding are complementary and should be used to form a good policy mix. One interviewee also suggested that they could be combined, utilizing the evaluation procedures within project support to validate proper R&D.

Involving more SMEs was also considered important, yet challenging issue. The rationale behind SME engagement was typically their importance in economic development and value chains. The current involvement plans and measures were typically considered marginal, although the set 15 % funding target and the undertaken streamlining measures in application and funding processes gathered positive receptions. The problem of engagement seems fundamental. The world of collaborative, long-term R&D projects is far from the world of SMEs doing their everyday business. Communicating between the actors in these different worlds is not always easy. Whether these two worlds can and should be connected, was a question that divided opinions among the respondents. There seemed to be two kinds of possible tracks: Either to fine-tune current measures to help involve a bit more high-performing SMEs that find their way into the system without addressing the larger masses of small businesses or to implement a change on a system level and aim for more ambitious SME engagement. The former view typically included skepticism over the possible benefits SMEs could bring, whereas the latter was typically connected with criticism towards the whole current system and the big role of large corporations.

The perceived main reason for SMEs not to participate lies in this same domain. The time, money and effort put to collaborative R&D projects are away from doing regular business. While this is true for any enterprise, it is especially true for SMEs. Unlike big corporations and research organizations, where there is dedicated people or even departments responsible for research and development, SMEs rarely have such 'slack' in their organizations. And with EU funded projects, dedication to R&D isn't enough in itself; one should also have legislative and administrative expertise and resources. These too, are usually lacking from SMEs. Although the current level of SME involvement shows that some SMEs believe that participation is beneficial, for most of the SMEs the participation doesn't seem to be attractive. Assumed gains do not seem to outweigh the assumed losses. Practically all the interviewees agreed that participation has to support business development in a relatively short-term, or the SMEs are not interested.

6.2 Benefits and barriers

It is not to say though, that there would be no gains or benefits in participation. The interviewees mentioned several benefits, gains and incentives that are interesting to SMEs. These are listed in Table 7 along with the mentioned barriers, which are discussed further below.

Although there are businesses specialized in applying public funding, in general funding itself is just an enabler. The participation rationale is something else. It can be need to create new business through new products or services, where collaborative R&D offers risk and resource sharing and extra funding. The projects can also offer a company an opportunity to try out new things that are a bit off from their usual core activities, without risking their current business or customers. Training and learning can also be achieved, as collaborative projects are easier way to obtain R&D and cutting edge technological knowledge than starting from scratch. Also awareness on market and trends as well as business model validation was among mentioned possible learning gains.

Still, the most emphasized benefits in the interviews were the networking benefits. EU funded collaborative R&D projects offer a unique way to get in touch with big players of the industry. These contacts can then turn into customers either directly or indirectly through references and improved reputation. Potential customers were frequently mentioned as the most significant attraction these projects can offer to SMEs. Also connections

to complementary firms and a frame for internationalization were mentioned as networking benefits. Most of the interviewees emphasized these indirect gains and stated that participation process is in most cases more important than the exact deliverables. It was however mentioned that when the deliverable does have a meaning for SME, it is typically very critical for the SME that the project succeeds and reaches its goals. SMEs can't afford to shoot many misses.

Table 7: Benefits and barriers mentioned in the interviews

Benefits, incentives – reasons to participate	Barriers, hindrances – reasons not participate
<ul style="list-style-type: none"> • Possibility to create new products or services • Trying new things • Sharing risk • Training and learning • Obtaining technology or market information • Channel to big players • Potential customers • Connections to complementary firms • Internationalization 	<ul style="list-style-type: none"> • Gains do not outweigh losses • Lack of resources • Long-term scale • Bureaucracy • Heavy reporting responsibilities • Slowness • High rejection rate • Bad reputation of inflexibility and bureaucracy • Unawareness • Complexity of options • Complexity of rules • More appealing opportunities on national level

As mentioned, the greatest single reason for participation according to the interviews is that the SMEs can't afford or do not want to invest their human and financial resources into participation. This lack of interest is a result of several barriers that the interviewees identified (see Table 7 for a summary). One fundamental was that the projects tend to have long-term scale, which is difficult for SMEs, that run their business mainly on short-term. The rest were typically related to either bureaucracy or communication.

Bureaucracy, inflexibility and heavy administrative burden were mentioned often as barriers, although it was regularly agreed that since public funding is distributed, there needs to be control and reporting responsibilities. As one interviewee put it:

"EU is not a trust based system. It is a control based system."

But with the size of the scheme, it is expected to be somewhat bureaucratic. Because of this approach, that bureaucracy is bad but necessary too, it is difficult to reason out from the answers what scale of a barrier it is. One mentioned problem however was that reporting responsibilities are challenging to SMEs, which typically do not have such practices in place unlike larger organizations and thus have to create them for the project purposes. Getting started was also criticized to be too slow, and it was stated many times that the

high rejection rate of proposals results in a lot of work gone waste. This was underlined by one interviewee who criticized that failed attempts do not teach much, since different evaluators have different preferences. This variation on how administrative rules are applied was also mentioned by others. Still, in many interviews the respondents pointed out that the bureaucracy is also partially folklore, and that it is perhaps not so heavy once you get used to it. The bad reputation was suggested to result from mixing the thematic FP funding with the structural funds, which are coordinated by national agencies and are known of their problems. One interviewee also suspected that certain actors, such as organizations that have exploited the current system successfully, keep this image of heavy red tape up in order to decrease competition.

Unawareness of opportunities was also mentioned as a barrier. The problem was mentioned to stem from both on the company and the European commission side. Related to the fundamental resource problem, the SMEs were said to not have time to scan or actively look for R&D funding possibilities, but even if they looking for information, it was described to be hard to find.

Related to the awareness, some of the interviewees suspected that the complexity of the different funding incentives provided by the EU make them difficult to approach from an SME perspective. The myriad of different programmes and schemes was described to appear as a confusing jungle to an interested applicant. Adding to the complexity resulting from the excess of options also the rules for participation were criticized as too complex and difficult to understand. (The rules regarding participation in FP7 are in fact spread among multiple documents not accessible from a clear central source [43, 44, 45, 136]). Besides these direct comments, the complexity showed in the interviews also in that there was often need for clarification as to what exact programme was under discussion. Only few of the interviewees had a thorough understanding of the all the different instruments within the EU R&D funding scheme, and these were people who are experienced and expert on the issue.

One barrier to European level R&D project participation was also the available national funding, which was described as easier to get, more known-of, less bureaucratic and more approachable. This factor was noted by multiple Finland-based respondents and one non-Finnish respondent. The logic according to the interviews is that the interested SMEs end up in national programmes instead of EU programmes. The same organizations are responsible for guiding SMEs to national and European incentives and were described to have tendency to guide the companies more towards the national level. One interviewee also mentioned that national or local level is usually more relevant for the SMEs business, so it is also more appealing. Somewhat linked to this issue, some Finnish respondents expressed that the EU funding should be more actively utilized, since it is funded partially from Finland. As one of them put it: "*We are stupid if we don't apply to get our own money back.*"

6.3 European and national level programmes

In the interviews it was also asked whether there should be a clear role division between European and national level R&D support schemes and if so, what should it be. In general, the respondents did not see need for systematic or strict division, but pointed out the differences in nature of them and had comments on how the emphasis should be set.

Many stated that EU funded projects should keep the ambitious aim and enable the riskier and more challenging projects. There needs to be "*EU value added*" as one of the interviewees put it. Thus, there needs to be a reason why a certain project is done within a

European project consortium and is eligible for the higher funding rates provided by the EU. Enabling and enforcing more collaborative view was also described as typical for EU level projects. It was stated that because of the large and long scale emphasis the EU level funding is not relevant for kick-starting new companies, which can be done on national level. (The requirements for SMEs stated by the interviewees are described further below in 6.6)

Couple of interviewees also suggested that the national schemes and European funding should form a continuum. One view on this was that the national level collaboration would be the first step for an SME, which could then proceed to the European level collaboration. Another view was that it might not even be relevant to involve SMEs so much on the European level, if they would have a larger role on national level. This idea included also stronger coordination between the projects and programmes run by the European Commission and by the national agencies. Relating to the coordination, it was stated by multiple interviewees that the national schemes should be developed to match the European level efforts, not the other way around. And as the national efforts were seen to have national missions, the EU funding was expected to have European mission, supporting the competitiveness and markets within the EU.

6.4 SME roles

When discussing the roles SMEs have in collaborative R&D projects, there were yet again many views present among the interviewees. In most cases the projected roles seemed to reflect the way SMEs were seen and described in general. The question of roles was typically continued with a follow-up question about whether the SMEs should mainly be considered as providers or exploiters of R&D knowledge. In this division, the majority of the respondents underlined the exploitative role, often referencing to the short-term focus of SMEs.

Still, various roles for SMEs were recognized. For example consultative, research and commercialization were mentioned as typical SME roles so that different kinds of firms have different kinds of roles. One thing noted by multiple respondents was that since SMEs typically have more narrow focus in their business and R&D accordingly, they are typically more suited to a role where they develop parts of a system, whereas the system level development is on the hands of big companies or academics. One mentioned role was also to act as a source of information about the needs and problems of markets, taking the perspective of an end-user of whatever is being developed.

This expertise on commercialization was often mentioned as strength and value that SMEs bring into project consortia. SMEs were also suggested by some to be more innovative than larger organizations, and to increase the impact and influence of the projects, representing the dynamic, regenerative component of the economy. Naturally the adopted role depends also on the objectives of the SME. According to one interviewee, the SME looking to develop their own special idea should take a bigger role and even coordinate a project, whereas if the goal is just to exploit a smaller, more peripheral role is enough.

The topic of how the SMEs find their ways to the projects was also discussed with some of the interviewees. In practice all of the respondents stated that previous contacts are the main channel for an SME to end up in an EU R&D project, although some also find their ways by their own activity either proactively or after been introduced to the system. Still, it was stated that the incentive is on the hands of the academics or big indus-

tries, who choose and ask SMEs through their existing contacts. This was said to be the case even for the Research for SMEs programme, which was described to be mainly a funding programme for university researchers. Whether this means that the incentive has failed, divided opinions. Also the existing contacts as the primary means to find SMEs got two-way feedback. It was on the one hand described as a convenient way and to ensure trust and good collaboration, but on the other hand it was stated to cause systemic risk.

6.5 Public-private partnerships

It was clear from quite early stages of the research that few of the interviewees were well aware of the FI-PPP or the European Commission funded PPPs in general. Thus the specific questions regarding FI-PPP rarely initiated any relevant discussion. Still, some insights and comments were gathered from those respondents that were aware of the structure.

The concept of PPPs divided opinions among interviewees. Some showed skepticism towards the concept, stating that although the idea is good, the practice this far has not delivered the promises. One respondent criticized the big role of big corporations and marginalization of SMEs, whereas another one pointed out too strong top-down mentality. Many shared concerns about the unclear structure and increased administration. It was also stated that in order to work, a PPP needs to have a clear, ambitious goal. It should be noted, that this criticism was towards PPPs in general, not FI-PPP.

Still, the FI-PPP received also positive feedback and expectations. It was stated that it seems to have a real commercialization focus and means to achieve actual exploitation. The cross-cultural and cross-sectoral nature was also brought up. It was said that the FI-PPP has brought together industries that actors that would otherwise perhaps not cooperate, creating new and expanding existing contact networks.

6.6 SME classification and requirements

As mentioned above, the categorization of different SMEs to help designing policies was a topic that initiated quite low amount of discussion among interviewees, perhaps a bit surprisingly. Although many noted that SMEs are generally not alike, many also stated that strict classifications are not useful and might cause more problems than do good. Still, interesting comments on different SMEs were collected, including insights on SME definition and capabilities required from SMEs taking part in projects.

When asked about the current SME definition by European Union (see 3.2), the interviewees brought up varying opinions. Interestingly, the suggestions to raise the limit to came from interviewees with a background related to big industry, whereas the considerations for to lower the upper limit came from respondents representing more the SME perspective. However most had no strong opinion or thought that the current definition is appropriate. What many noted was that there is big difference among the characteristics of micro, small and medium companies, and that their capabilities differ a lot. Some suggested more emphasis on this sub-division according to size. This was suspected to help the smallest companies. It was however also noted that the enterprises a bit bigger than the SME limit are still far from true big industries and that growth sometimes causes problems as the firms grow bigger than the definition.

Although systematic classifications were mostly avoided, the interviewees identified many distinct types of SMEs within their comments. One distinction made in the in-

interviews was separating 'real SMEs' or 'basic SMEs' from the SMEs who have adapted themselves to utilize existing R&D funding schemes, for example by specializing in contracted R&D, consulting or other special activities whose market largely exists within the scheme. Also SMEs with too obvious connections to big industries were mentioned as a problem. It was noted that all these specialized SMEs already find their ways into the programmes, but the challenge lies in engaging the masses of real, business doing SMEs.

As interviewees were asked about growth companies, many commented on possibilities to involve them on the projects. Relating to this, start-ups were discussed as well. Although it was mentioned that university spin-offs are capable of developing interesting new technologies, many were skeptical about targeting engagement to start-ups. Inflexibility causes problems especially to start-ups, who are still looking for their exact business models. It was suggested that they can be difficult to serve within collaborative R&D projects and that local support instruments and fiscal support are more useful for them. Similar skepticism was also pointed towards micro sized enterprises in general, but couple of interviewees expressed positive expectations towards involving ambitious growth companies to increase the impact of the projects.

Perhaps because of the interviewee composition, some sector specific distinctions were made in the interviews. Multiple respondents noted that in software business the relevant division is between companies that develop products and companies that provide services. For product oriented companies participation is easier, since they can combine their product development with the collaborative R&D efforts. Service oriented companies are more dependent on the continuous cash flow and customer projects. Still, it was noted that a consulting company can put the slack time between customer projects into collaborative R&D projects. This way an employee can be used to do productive work and at the same time learn and create useful contacts. It was also noted that collaborative R&D projects are a way for a service oriented company to gain ownership to a technology or solution, as they typically are left for the customer.

Another sector that was represented among the interviewees was creative industries. It seems that the SMEs in this field face somewhat different problems in participation. It was noted that in creative industries there is much more direct competition between the big corporations and the SMEs. This issue was described to culminate in IPR issues. If a creative industry SME participates in a project in which the ownership of the essential outputs will be shared with large players (or even other SMEs) the cooperation is not usually attractive.

One issue related to SME classification discussed within the interviewees was also the requirements for SMEs that participate. This issue is naturally connected to the question of what kinds of SMEs should be targeted in the engagement activities, and this was the tone actually used in the interviews. There were no mentions about systematically limiting participation if the requirements are not met but the discussion was more about what kind of SMEs would best benefit the projects and themselves too. The requirements mentioned in the interviews are summarized in Figure 9.

One key requirement mentioned in many of the interviews was interest. It was stated that a participating SME should be interested in the project and internationalization. Internationalization was set to require courage, competence and connections. A related, often mentioned issue was also language. In practice the SMEs need to be able to communicate in English, although in theory it is not required. The SMEs were also expected to show innovativeness and expertise in order to bring value to the projects. Some put this in the form that they should show high R&D intensity or experience from the national level projects. Financial and operational stability was also mentioned as a requirement, ruling out

most of the micro sized firms. One interviewee had this similar approach, but concluded that the SME needs certain amount of legal and organizational capabilities to cope with the administrative duties like reporting. The viewpoint of this interviewee was perhaps slightly different from others, answering from the viewpoint of what kinds of requirements the current rules and practices pose to the participants. The rest of the interviewees responded from slightly broader perspective.

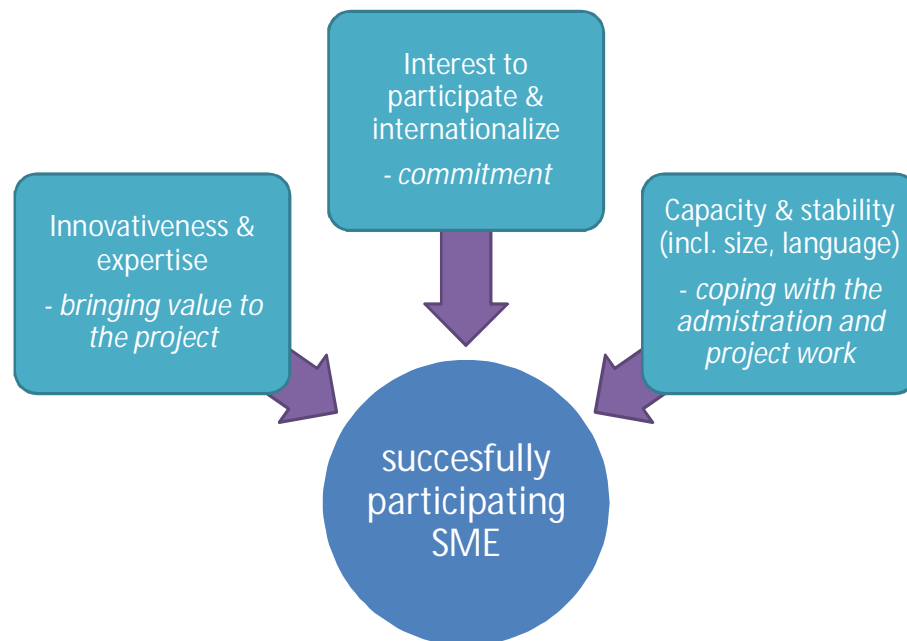


Figure 9: Requirements for the SME for successful participation summarized from the interviews

When discussing different types of SMEs, some interviewees commented on how different instruments should be targeted to different SMEs. One referred to the “Research Stairway” by EURAB [117] as a good framework to use when positioning different instruments among different SMEs. Another one pointed out, that different programmes can have different rules for participating SMEs (and target different SMEs) but within a same programme all SMEs should be participating under the same conditions.

6.7 Measuring engagement

The issue of measuring SME involvement was also brought up in the interviews in one of the questions, and led to some interesting comments although the topic was in general considered challenging. Many emphasized that the funding target is necessary to guarantee that actions are taken to involve SMEs. The 15 % was also suggested to be raised.

Most interviewees were content to note several aspects that should be taken into account when thinking of measuring the success of SME engagement. One respondent noted that good indicators may vary between industry sectors. Others pointed out that commercial perspective and impact assessment should be included. It was however noted that commercial results and impacts might come with delay, and that risk is intrinsic to

R&D projects and thus instead of success of end results the cooperation, gained skills, knowledge and competence should be evaluated. But more detailed indicators for the results were also suggested, such as employment created directly (in the companies) and indirectly (through the technologies) by the project, internationalization of the involved companies, resulted patents and their exploitation as well as the amount of private investment in the delivered technologies. One also suggested that extra commercialization support mechanism (see below) could serve as a tracking mechanism as well.

Still, multiple respondents noted that setting up indicators is always a tricky task. One suggested that the validation and evaluation should be made by people, since it is not possible to build perfect measuring system. One type of evaluation made by people is peer-review among the project participants, an idea that was brought up by one of the interviewees. As this was considered as an interesting suggestion, it was brought to the question set and the comments are discussed below in the next part.

6.8 Policy recommendations

In the final substance part of the interviews, the respondents were asked to comment and discuss various policy measures aimed to increase the involvement of SMEs. These measures were picked mainly from previous literature, but they were also picked to the developing question set from earlier interviews. The idea was to talk about EU funded collaborative R&D in general, although many of the respondents referenced to Horizon 2020 (as they noted that FP7 rules are unlikely to change any more). Adding to the common questions, the interviewees familiar with the FI-PPP were asked what should be done within the programme to engage more SMEs.

The feedback about measured ranged from positive to neutral to negative, and the responses are summarized in Figure 10. It should be noted though, that this was not a quantitative survey, and the most valuable results lie in the qualitative comments described below.

Recommendation to decrease bureaucracy got practically unanimous support, although few noted that some level of bureaucracy is necessary to maintain working administration and to prevent misuse of funding. A mentioned problem was also lack of stability and quality; it was complained that the way rules are applied vary between project officers and that constant efforts to change the system – although for the better – make the process even more difficult, as the SMEs need to adjust to new rules. It was stated that reporting should be made lighter, and it should emphasize on what is being done and achieved instead of how many hours have been used. Increasing flexibility was also asked for, so that the projects could adapt to changes in business plans and agile development. One interviewee also suggested that associate partner mechanism should be returned, so that SMEs could participate with less administrative and reporting responsibilities.

The suggestion to encourage more smaller, lighter projects got a more diverse response. The idea to fund more but smaller project got support, as it was suggested that such projects would not be so attractive for big corporations to dominate and they could be used as entry step towards larger projects. Small projects can also be more practical to SMEs, but it is not easy to get funding for them. As one interviewee put it:

" Sometimes it feels like it's harder to get 35,000 than 5,000,000 euros."

Smaller projects were however criticized not to serve the research needs. Although development towards smaller projects was supported, the idea of having shorter projects was

largely disliked. It was stated that given the administrative requirements, there is no point in setting up collaborative R&D project for a time of half a year for example and that long-term working is part of the nature of research work. One interviewee added that longer projects can also mean longer customer relationships and getting to know the people one is working with is important. Still, it was stated that current project-time spans are long from the perspective of commercialization, especially on fast paced sectors such as ICT.



Mainly positive	Divided	Mainly negative
<ul style="list-style-type: none"> -Decreasing bureaucracy - Enabling SME participation for only part of the project - Smaller project consortia -Improving communication and dissemination -Improving IPR protection -Supporting customer creation 	<ul style="list-style-type: none"> - Smaller projects - Two-stage application process -Engaging SMEs in design, planning and evaluation -Extra support for commercialization at the end of the projects -Improving payment conditions -Co-operation with private investors -More open project calls -Peer review of project participants -Training project officers on SME needs and challenges -Enabling SME participation in groups 	<ul style="list-style-type: none"> -Higher funding rates -Training project coordinators
		

Figure 10: Summary of responses on the measures by the interviewees. In many cases, the measures that got divided feedback were considered good in theory but impractical.

When discussing about lighter projects, separating the big projects into smaller ones was also suggested. The idea of enabling SME participation in later stages of a project or just part of the project was another measure commented as well. It was generally considered a good improvement, as long as participation for the whole project would be kept as an option. Partial participation was thought to bring flexibility and make the participation more attractive to SMEs looking for commercial exploitation as they could join in after the initial ideas would have narrowed down into more concrete options. Also, to some SMEs participation only in the beginning could be attractive. They could bring in market knowledge or technical expertise needed in setting up the project and doing the early stage research (an SME specialized in simulation technologies was given as an example). Associate partner status, slicing small projects from bigger projects and innovation vouchers were suggested as possible ways to implement later stage and partial participation in practice. The vouchers would be handled to project participants with more administrative resources, who could then use them to contract SMEs to the projects.

Besides smaller projects, moving towards smaller project consortia was also a discussed measure and got a mostly positive response. According to the interviewees, smaller consortia would ease up project administration and speed up processes. They thus

help in engaging SMEs. However, it was also said that there is a tradeoff between size and impact, with smaller projects leading to lesser impacts and that SMEs actually prefer big consortia since it means less work but greater exposure to contacts. It was also noted that there is need for projects of different sizes. One respondent also said that current rules are not the problem, but the interpretation is since at the moment big project consortia are favored.

Utilizing two-stage application processes instead of single-stage was a measure that got more divided response in the interviews. Although many perceived benefits in the procedure, such as decreased waste work, many problems were also pointed out. One noted that it doesn't necessarily remove the risk related to high rejection rate, other one expressed concerns that good proposals might be combed off. Some also criticized that two-stage application process is slower. One respondent stated that the process only works if there is enough elimination in the first round. Couple of interviewees mentioned that it would be good if there would be a way to get quick, good feedback for an idea, although it wouldn't necessarily require an extra application round.

The next measure, improving communication and dissemination, was presented in the interviews in a couple of different ways, as the question set was developed. The answers can still be considered comparable giving the semi-structured nature of the interviews. In general the interviewees agreed that improving communication towards SMEs is necessary and often pointed out similar methods and emphases that could work. Word of mouth and communicating successful example cases were suggested, as well as proactive approach in general. It was underlined by multiple interviewees that the SMEs need to be presented with the possible business benefits. Many emphasized that to reach the SMEs the message needs to be where the SMEs are. This was often continued with stating the necessity of local communication activities, in which local networks could be utilized. Associations, chambers of commerce and regional and national agencies were mentioned as such channels, although there was also comment about that the associations are not very effective way to reach the SMEs. It was noted that the contact points need to be in a relevant context and place in relation to the SMEs and their business. Conferences, business fairs and other events were mentioned as examples of such. In addition, Media Desks run by the MEDIA programme [149] of the European Commission were given as examples of successful localized communication by two of the interviewees.

What many of interviewees underlined, was that targeted marketing is necessary. The SMEs are not reached by the same efforts as researchers and big companies, who actively search for information. As one interviewee put it, there needs to be communication on two levels: basic awareness creation and marketing specific calls, projects and programmes.

Another suggested measure picked for the interviews was engagement of SME in design, planning and evaluation of the projects and programmes. It led to a variety of comments. Couple of interviewees doubted the practicality of the idea, as SMEs are unlikely to have the resources to do such work. Also it was noted that such forums exist already, but have remained a thing of small circles. Still, the idea received support too. It was stated that SME perspective is currently not presented enough and that they could bring in understanding and information about markets. It was noted that doing evaluation also trains to do better applications, so getting more SMEs to participate would be beneficial. One interviewee was however worried about too high commercial bias in evaluation, if SMEs are involved in large numbers. Some interviewees also suggested more practical approached to the engagement. It was pointed out that experienced entrepreneurs could be both interested to participate and a good source of knowledge on commercialization. Another sugges-

tion was to involve the SMEs in the design, planning and evaluation within JTI and ETP schemes, which would require fewer resources.

Extra support for commercialization at the end of the projects also gained divided reception among the interviewees. Although many saw that the idea is worth trying and developing, some noted that real markets and customers are inevitably needed and the focus should be on finding those. Also market distortion was mentioned as a threat. Some noted that there is likely to be delay between the ending of the project and the successful market entry and that this should be taken into account in the mechanism. It was underlined that the support should not be automatic, as all the projects do not lead to market applications. One interviewee was skeptical about the competence of European Commission to choose which projects to give extra aid to. Interviewees also referred to existing mechanisms as CIP and trials in FP6 were mentioned as examples with not totally positive experiences.

In talks about higher funding rates for SMEs most interviewees did not see it as a beneficial measure. According to them, the rates are already high and self-financing helps to ensure the commitment of the participants. Many stated that raising funding rate would not act as an incentive and one suspected that it would lead to more speculative companies to enter the programmes. Still, some argued that applying higher rates would bring in more productive SMEs, as it would lower the barrier especially for the smallest companies and help the top notch companies to justify participation. One interviewee suggested that for first and second timers there could be higher funding level, aimed to fund learning and activities related to the application process.

Besides higher funding rates, improving payment conditions in general was also presented to the interviewees as a possible action. The conditions were described to be on good level already as most of the payments are paid in beforehand. Still, many pointed out that any payment coming afterwards is problematic especially for the smallest companies. It was stated that some SMEs can't afford to participate if the payments are paid afterwards.

Co-operation with private investors such as venture capitalists and business angels was seen as challenging by most interviewees. Some suspected that such players have no interest for such early-phase projects, whereas others noted that private investors are supposed to watch such projects anyways, but that the political, economic and mental atmosphere in Europe results in lack of such investors. Many noted the smallness of the scheme. Still, according to some respondents the idea is good. Venture capitalists were said not only to bring in welcomed extra funding, but also knowledge and networks helpful in commercialization. The personal accountability of funding that these investors represent was also suggested to help in keeping up the market relevance. It was also noted that project and enterprise funding need to be kept separate.

Recommendation to move towards more open project calls spurred a lot of commenting as well. Some criticized the level of detail with what the Commission determines the calls, whereas one was more understanding, noting that it is important means for political control for the limited funding. More flexibility and less control were yearned for. Involving more commercial actors in shaping the agenda was thought to be a good thing by some. However one interviewee stated that often the problem is that the calls are tied too much into the interests of the leading market actors, when they should be aimed to increase competition instead. It was also noted that the Commission plans originate often in ETPs, and the change should happen there. Still, some interviewees also commented that open calls do not benefit SMEs, as it is difficult for them to respond in them or that the issue is not very relevant. One pointed out that open calls will be tried in one of the FI

PPP projects and the results should be waited for. Another one mentioned that including end-user descriptions in the calls has received good feedback and is an advisable practice.

Peer review of participants was suggested by one of the interviewees as a measure to tackle free riding and other problems in projects, making thus the participation more attractive to real productive SMEs. It was picked up in the question set, and received divided feedback. Although one interviewee supported the idea, other described it irrelevant and even dangerous. It was stated that the word about reputation spreads already and shouldn't be stored into any database.

Training of project officers on SME needs and challenges was both supported and questioned. Many agreed that project officers should have a better understanding on SME realities, market situation and commercialization opportunity identification. Some however stated that better than training the project officers is to utilize external experts such as SME representatives on these topics. Training project coordinators was less discussed, and the main points made were that good coordinators are essential success factors and that as much as possible of the funding should go to the company funding and not into structures. Specialized coordinators and knowledge brokers were seen as better solution than training researchers about the SME world. Some interviewees pointed out the importance of training SMEs on how Framework Programmes work and how to apply for public funding and act in today's innovation environment.

According to the interviews enabling SME participation in groups or clusters might work, but also doubts were expressed. Clear leadership, conflicts of interest, division of work and ownership of results were mentioned as issues that should be thoroughly thought in order to the measure to success. One interviewee noted that group participation has not worked in Research for SME associations, and another one stated that attempts to match SMEs with each other are a waste of time. It was also stated that individual SMEs still need to be engaged. Associate partner mechanism and value network perspective were suggested to be applied with group participation.

When discussing about improving IPR protection some interviewees saw that the issue is not very relevant whereas others considered it critical. Many stated that the guidelines and rules should be as simple as possible and nothing should be left unclear. One interviewee especially emphasized that the more room is left for project-specific negotiation, the more power the big corporations with legal expertise get. Moving more towards open innovation philosophy was suggested, but IPR ownership was also in many occasions described as an incentive to SME participation. One interviewee pointed out that the price of patents is high for SMEs, and it should be supported as part of exploitation.

Supporting customer creation by involving public or private procurement or other means to match supply and demand was one of the possible measures that came up on the interviews and was added to the question set. The suggestion remained perhaps somewhat vague, but inspired constructive comments. All of the respondents who got to comment the issue were positive towards it. Public procurement was described to be a very powerful tool, although it was noted that it does not work in privatized sectors of economy and the European Commission itself is not very significant buyer. Also point was made about the problem that inclination towards favoring old contacts when searching for participants does not go well with the procurement idea.

Another measure spawned from the interviews and a bit vague in its definition was emphasizing value chains when building consortia, which was commented only by few of the interviewees as it was added to the question set in quite late stage. According to one interviewee successful projects are often built on value chains, and having relevant big players involved makes projects more attractive also to the SMEs. Another interviewee

noted that value networks would also derive customer relationships and that there is in general no point in looking at just SMEs or individual companies but the focus has to be on value networks.

All in all, the part of the interviews where different measures were commented provided lot of interesting insights that also helped to understand the answers to the more open questions. One important aspect in analyzing the results is however the structure of the part; the interviewees were not asked in any way to compare the different measures or rank them, but to give their qualitative view on them. Thus concluding the best actions to take according to these results is not possible.

The interviewees that were familiar with FI PPP were asked in addition to provide their recommendations on what should be done by the CONCORD project in FI PPP particular to achieve high SME interest and involvement in the later phases. The most emphasized actions were marketing and communication; according to these interviewees CONCORD should strive to raise awareness of FI PPP among SMEs, both in general and with a more tangible 'what's in it for me'-messages. One interviewee stated that in order to be interested in FI PPP the SMEs first need to understand how Framework Programme structures work in general, how the participation process works and what the possible benefits are. It was also stated that regional events are needed, for which support organizations and industry associations should be utilized. Besides the SME targeted communication, it was also suggested that CONCORD could act as an intermediary through whom the projects could share their SME engagement experiences. This way, best practices could be effectively spread.

6.9 Chapter summary

The interviews produced lot of interesting material valuable in developing SME engagement actions. The aim to increase the involvement and its impact was generally considered important, but very challenging. According to the interviewees, the main issue in getting the SMEs to participate is the apparent discrepancy in fitting the short-term reality of business into ambitious R&D goals. The interviews also help to evaluate which of the possible measures might work and what has to be taken into account in implementing them.

7 Synthesis and conclusions

This chapter concludes the findings of this study, synthesizing the literature review and the empiric study presented in the previous chapters. The chapter is structured around three new approaches that were developed according to the central findings of the study. These approaches are titled *Positive discrimination*, *Communicative interface* and *Value network approach*, presented in Figure 11. With the description of each approach, the main findings justifying it are presented. The approaches are recommendations by nature but are more theoretical structures guiding policy design instead of practical action plans. Presenting these approaches is followed by a set of recommendations for the different levels of R&D project administration and suggestions for further research. Finally, suggestions for further research and a conclusive summary are presented.

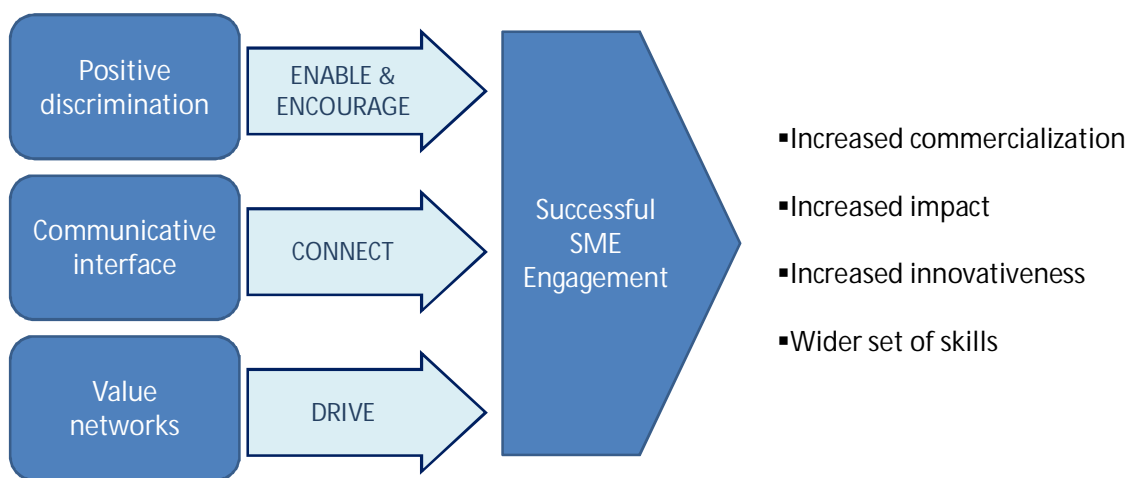


Figure 11: The three approaches supporting successful SME engagement and the benefits for the projects

7.1 *Positive discrimination approach*

Improving SME involvement or engaging SMEs is a frequently mentioned issue in various reports, policies, papers and presentations. However, small and medium sized enterprises are a very heterogeneous group of companies, and naturally the SME definition itself is just a political decision. The current definition is however working, at least if the differences between various types of SMEs are also taken into consideration. It is justified to make sure SMEs are represented as they have a major role in the economy and as a source of new innovations. Still, goal setting is necessary to guide actions, and plain 'SME engagement' alone is too vague. So, it is necessary to map out what are the desired roles for SMEs, what value do they bring and also what is expected from them. On the highest level the 15 % funding share target is necessary to guarantee that SMEs are not neglected, since SMEs are often the most difficult group of actors to get into projects. But it doesn't guide actions enough on the PPP or project level, so the approach to engagement needs to be specified further.

Typical and most natural role for an SME in a collaborative R&D project is related to exploitation, but they are also giving input into more pure research. Although commercialization is more relevant in the late stages of the project, market information and 'end-user' perspective are often valuable also in setting up a project. SMEs are a good source of this knowledge, representing the dynamic, regenerative component of the economy. Exploitation then in turn increases the impact and influence of the research and development.

To increase the exploitation, the real, business doing SMEs need to be involved. The research or consultancy oriented small businesses are welcome too, but they are not the answer to the challenges of commercial exploitation and the SME engagement shouldn't rely just on them. These 'real market SMEs' in general share certain characteristics: they are interested in short-term gains and are very dependent on cash flows. These aspects are naturally connected. It's not that they are greedy and short-sighted, but they lack the resources to do major investments for the long run. This is what fundamentally separates these SMEs from big corporations and research organizations; they do not have dedicated personnel or funds to be designated into collaborative R&D projects. For SMEs any time or money spent on these projects is away from doing regular business in a very concrete way. Small and medium enterprises lack the 'slack', and thus the gains from participation need to outweigh the direct losses in regular business. The fact that this balance is not usually clear is the main reason keeping SMEs out from the projects. This should be taken into consideration whenever planning the SME engagement – SMEs need to be considered as their own group, and be granted some *positive discrimination*. In practice this means that some exemptions regarding SMEs are justified, but these should be voluntary in the sense that if an SME is fully able to participate by the same conditions as a big corporation, it may choose to do so.

Examples of such positive discrimination currently in place include high funding rates and the 15 % target funding share. While these are justified, more support should be provided, and it should be aimed to activate the SMEs. The role of positive discrimination approach is not to provide reasons for the SMEs to participate, but to enable and encourage them to participate. IPR negotiations and administrative burden, especially reporting, are focal issues where more systematic support is needed and where a lot could be done to activate the small and medium businesses.

But it is clear that not all SMEs are capable to participate in demanding international collaborative R&D projects. SME involvement can't be charity or welfare; the enterprises need to have instrumental value to the projects. The participating SMEs need to have interest in the project as well as interest to go international. Naturally they need to present some level of innovativeness and expertise or skill set valuable for the project, as well as reasonable language skills. Certain level of stability in finance and organization is typically necessary too, especially unless the administrative workload is not drastically decreased. This rules out many of the smallest micro and start-up firms, meaning that they are not the most relevant target group of SMEs, but shouldn't be categorically ruled out either. On national level, the requirements are generally lower, so national and European level funding programmes should form a continuum.

The requirements are difficult to specify in detail, as there are major differences in the industry structure and innovation cycles between different industries. The exact role of the SME affects also, as well as the business model; it is for example easier for a product oriented enterprise to participate compared to service oriented enterprise, and still both can be valuable partners in the projects. So, instead of setting specific requirements, the issue

should be considered in the communication and marketing of the programmes and projects.

The exact SME definition used defines the target group for the special support measures. It should only be altered after careful consideration, and at the moment there doesn't seem to be any need to change it. If anything, the sub-division into micro, small and medium could be used to fine tune the support mechanisms, but this shouldn't be on the cost of system simplicity, as is explained next.

7.2 Communicative interface approach

As mentioned, the main reason not to participate for SMEs is that participation usually disrupts their day-to-day business, and they might either not afford it or believe that the gains outweigh the costs. This root cause is complemented with many barriers hindering the participation, with the major ones being unawareness of opportunities and heavy bureaucracy.

Unawareness stems not necessarily from poor communication but from the complexity of options. The European Commission funded opportunities for an SME to increase innovativeness or participate in collaborative R&D are a mixed jungle; there are the Framework Programmes, thematic programmes under it, the PPPs, EITs, JTIs, CIP and many more. For an SME not familiar with these structures it is practically impossible to understand the options just by searching for information on their own. And even after an attractive programme or project has been found, the rules of participation are far from simple or easily accessed. Even the language is tricky, as words like innovation are used but not coherently defined. At the moment most of the SMEs are found in the projects by previous contacts – there is nothing wrong in this, but in order to reach substantially more and better SMEs it's not enough.

The bureaucracy is a never-ending issue - EU level R&D funding scheme is not a trust-based but control based-system, as one of the interviewees put it. Still, it is inevitable because of the size scale. The SMEs accept certain level of administrative work in exchange for generous funding rates. One problem is that the exact practicalities change according to projects and project officers. The extensive red tape is also partially folklore, stemming from previous policies and other types of EU funding, such as the structural funds. The biggest administrative problems are related to proposal stage, where getting started is considered slow, and the heavy reporting duties. In the proposal stage another problem is high rejection rate, which mean a lot of waste work, and feedback from a rejected proposal isn't necessarily helpful for the next try.

There are myriad different measures to tackle these barriers, but the main things are the will to do so and the overall perspective when doing so. A lot can be achieved by marketing the opportunities through right channels, but the communication and the structure behind are intrinsically intertwined. The emphasis should be on designing the communication interfaces from the SME perspective. When an SME gets interested in EU funded R&D, it should be able to quickly access the most relevant information; what options does it have, and what does it have to do to take use of those options. The whole process of participation should be clear as assessable before taking the first step. The structures need simplification from the participant point of view, not from the commission point of view. But this takes time, and during the process the emphasis should be on designing the interfaces – in the web, through the National Contact Points and wherever the businesses are present. Well-designed communication interface would connect the different actors and

information, bringing the right SMEs to right projects. The idea of communicative interface approach is presented in Figure 12.

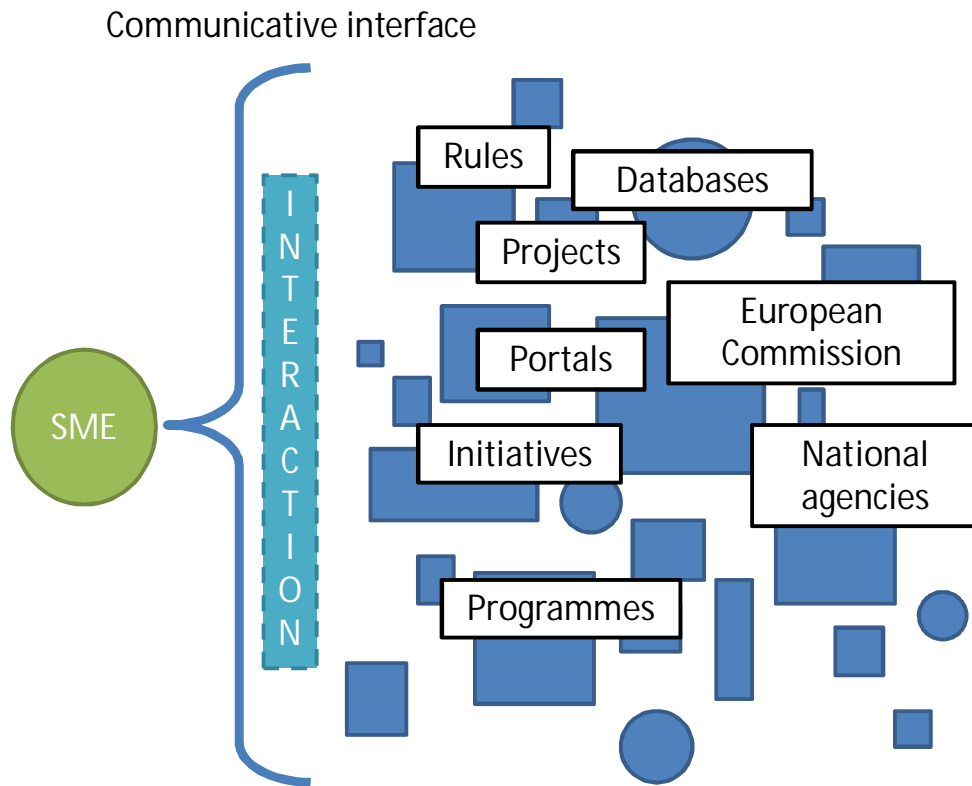


Figure 12: The idea of communicative interface approach

Interface also includes interaction, so it should be taken care of that the feedback flows in both directions. This should be true already for marketing and communication of opportunities, which should be proactive. Also rejected applications should result in useful dialogue between the SME and the evaluator. Failed attempt should help in applying next time and in best case also in business model validation. Openness of calls is also part of the interface. There is most likely need for different kinds of goals, but in general the setup should be such, that the Commission can provide closed, narrow goals, but it should be open about solutions. The funding model should be simple too.

By necessity the various national schemes should be taken into account when developing the interface for the EU funded collaborative R&D scheme. The European level system cannot however be designed according the terms of national instruments, but rather vice versa. The variety of different SMEs should also be taken into consideration, providing examples of different ways to participate. Different programmes can be aimed to different SMEs and thus probably need to have slightly differing exact rules, but the general logic should be common to all. As for systematic categorization of the SMEs, there seems to be no need to implement such in the system.

7.3 Value network approach

Enterprises participate in collaborative R&D projects for various reasons; to share risks of R&D, to try out new things, consensus building, creating contacts and building networks for example. On a general level the prime motivation can be distinguished into two different drivers: technology orientation and market orientation. The former denotes the learning, training and knowledge benefits, whereas the latter highlights product or process development and building business networks. For SMEs, these orientations somewhat converge, thanks to the necessity of short-term gains. If the developed technology doesn't meet the expectations, the networks and experience should alone justify the effort put to the project. Although SMEs don't necessarily want to bring in their core business assets into collaborative projects (especially in creative industries) they can't afford to tinker either.

Both the technology and market oriented SMEs should be welcomed as the same companies can vary in their orientation according to projects. A software service firm can join a project for example to use it to train their people between customer projects or it join to create connections and customer references. In general, one of the most valuable things an SME can get from a project is a new customer. Especially the young enterprises are in search of key customers. To attract good SMEs independent of their orientation value network approach should be used. This idea of value network approach is illustrated in Figure 13. Exposing the SMEs into attractive networks could be the driver that would get them to participate.

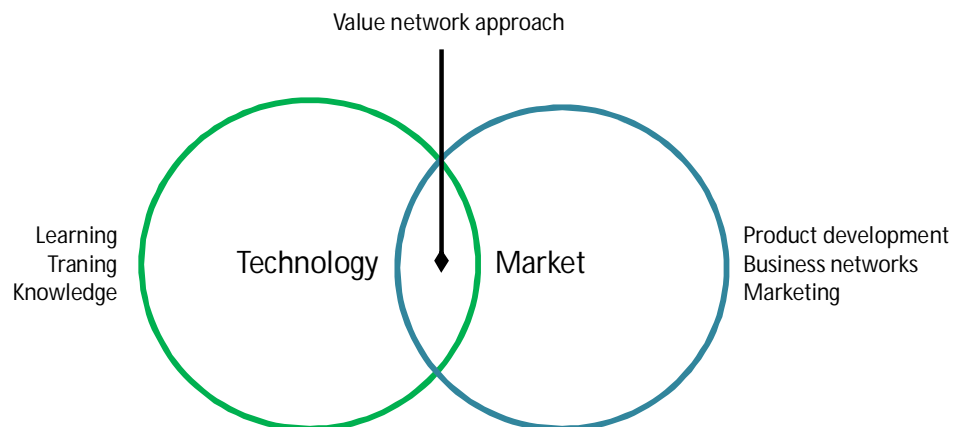


Figure 13: Value network approach combines the technology and market orientation

In this approach value network would be used to design the project and its roles, and to communicate the scope and idea of the project to potential participants. Previously, end user descriptions have been used in calls to concretize them to SMEs. Value network approach would include this view and also take into account that SMEs do not need or want advice on how to do business. That is already their expertise. With value network description it would also be simple to present the connection between system level efforts, which is typically the responsibility of big companies or research organizations, and subsystem or partial level efforts, which are typically the responsibility of SMEs. Figure 14 presents an example of generic value network visualization.

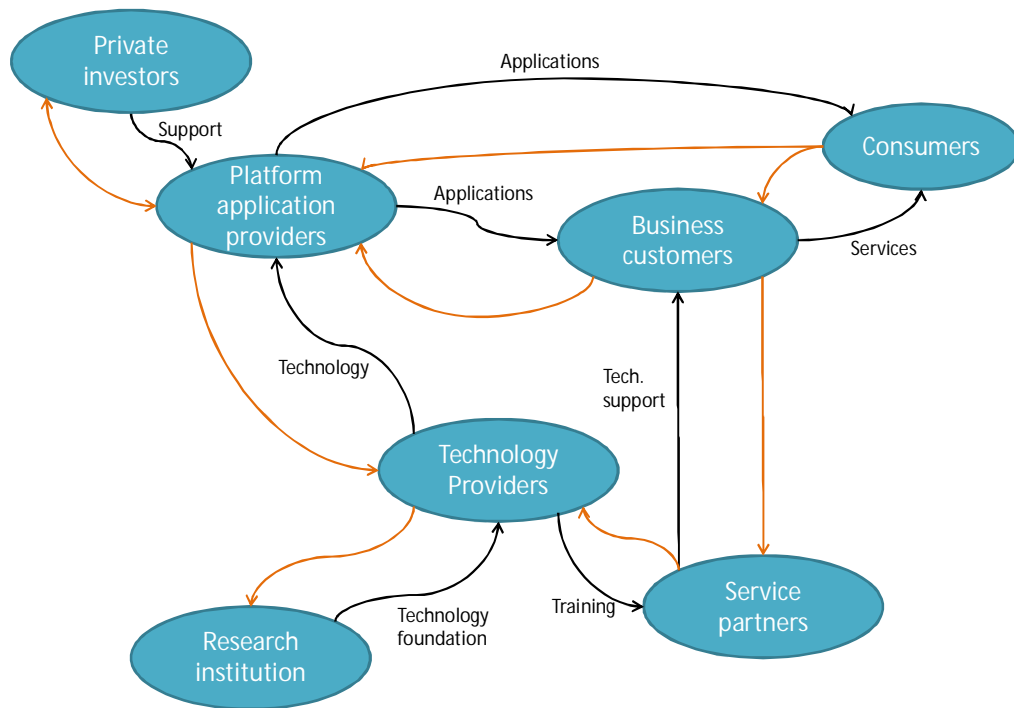


Figure 14: Generic value network representation, black arrows represent deliverables, red arrows payments (modified from [150])

Using value network model as a basis for consortium building would help in reaching over the exploitation gap, since the network itself is practically a description of exploitation. It would be easier also to communicate the available roles to SMEs, making it straightforward for them to assess whether the project fits their business model and thus to evaluate their possible gains. Value network approach would also help to ensure that the customer viewpoint is represented or thoroughly thought of in the project. It is however important to understand that the value network can be developed and refined during the project, starting from a rough idea and ending up at best in a concrete idea on how to bring the deliverables into the market. Other aspects to be kept in mind are that not all projects can lead to successful exploitation and that value networks need to be a tool to increase competition, not to distort it.

7.4 Recommended measures

As said, the core reason SMEs do not find their ways in EU R&D is that participation is not additional but competing with regular business on the scarce human and financial resources an SME has. And even if the gains outweighed the losses, complex offering of information and heavy administrative workload hinder the attractiveness of involvement. Implementing positive discrimination, compiling a communicative interface and focusing on value networks are the cross-cutting approaches that would support SME en-

agement, but they need to be turned into practical measures. Different measures are relevant on different levels; some need to be implemented on the Framework Programme level, some on programme level (such as FI PPP) and some on project level. In Figure 15 some measures are presented according to the relevant level and approach.

Each level frames the possible measures available for the next. The rules set for Seventh Framework programme determine the rules for FI PPP, and FI PPP guides how the projects are implemented under it. In this sense, the problem is that the FP7 will run with current rules until its end, and major changes will have to wait for Horizon 2020, the next Framework Programme. This can however be circumvented to some extent; for example FI PPP could produce a simple, usable participation guide to replace the complex ones provided within FP7. The positive discrimination measures are however difficult or impossible to implement without official policy changes at the FP level.

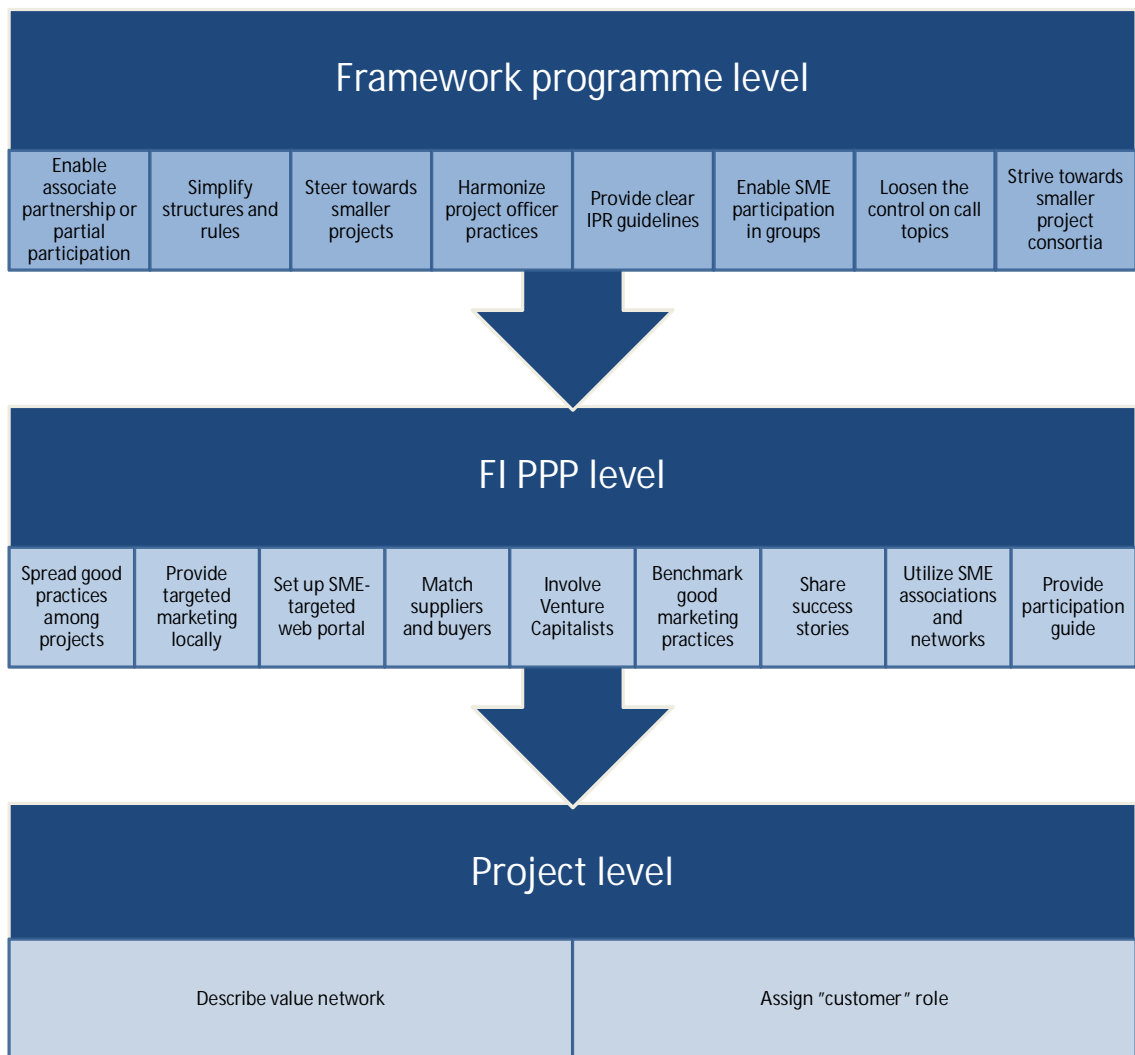


Figure 15: Suggested measures on the different levels of implementation

On the highest level the SMEs could be supported by enabling associate partnership or partial participation and by funding more small projects and encouraging more

small project consortia to be formed. Having more variety in project and consortia size would provide opportunities for different SMEs. Also enabling SME participation in groups might be worth a try. The interface could be improved by simplifying structures and rules and harmonizing project officer practices. Finally, the control on call topics should be loosened, giving more room to innovative business and implementation ideas.

In the FI PPP level, there are many possible measures to take. The facilitating CONCORD project could spread good practices among projects, benchmark working marketing practices. Marketing the programme should be targeted and have local dimension, in which SME associations and networks as well as success stories could be utilized. SME targeted web portal and special participation guide could be useful tools in helping out the small and medium businesses find their way into the projects and in lowering the barriers to participate. Also, the expertise of private investors such as venture capitalists would be valuable to incorporate. Still, providing SMEs customers by matching suppliers and buyers would be the most important driver that would attract the participants.

As Figure 15 shows, there are not so many suggested measures for the project level. The value network should be used as a tool to guide the project, and it should be taken care that the customer perspective is presented especially as the project moves closer to exploitation. The low number of recommended measures is partially stemming from the research setting and partially because the projects just play by the rules set on higher level and rely on guidance and support from the programme or PPP level. Still, the actual work is done within the projects, so the coordinators should make sure that the SME engagement effort is taken seriously and there is open atmosphere for new ways of working.

7.5 Suggestions for further research

It is clear that because the broad scope, this study is merely an overview instead of in-depth study. Still, building a qualitative empiric study on the extensive literature review helped to form valuable new approaches to the topic. As presented in Chapter 4 broad quantitative studies have already been carried out previously, and it is unlikely that broad surveys on applicable measures in general would bring much more useful knowledge. Conducting research with a more narrowed down focus would most likely be more valuable instead.

Applied research about the bottlenecks and points of leverage during the whole participation process from the SME perspective could bring interesting insights on how the communicative interface approach should be implemented in practice. The methodologies from the user-centered design could provide suitable concepts and tools to be utilized in the development. Another interesting topic to study further would be the decision-making process as experience both by the SMEs that decided to participate and by those who didn't participate. For this, the critical incident technique might be applicable.

The idea of implementing the value network approach in projects and programmes should also be researched as a case study or otherwise. Within the domain of economics, there are without doubt myriad research topics related to the economic effects publicly funded collaborative R&D support. On the microeconomic scale the impact on single participating company in terms of growth or innovativeness requires more studying. In the field of macroeconomics, the most beneficial policy mix of direct funding and indirect incentives is most likely yet to be discovered.

7.6 Conclusive summary

Small and medium enterprises play important role in providing jobs, creating new innovations and within the value networks of different industries. Besides this, in the collaborative R&D project level, SMEs can bring technical and market expertise as well as new ideas and ways of working to the consortia. For these reasons already, successful SME engagement is a goal worth striving on. SME engagement however as a term is vague, and needs to be specified and measured. It should aim to increase the quantity and quality of SME involvement.

SMEs are however heterogeneous group and typically very different from each other. Still, there is a clear attribute distinguishing them from the other key stakeholder groups; large companies and research organizations. It is the lack of available resources to be dedicated to projects or proactively searching for project opportunities. The tradeoff between collaborative R&D participation and doing everyday business is concrete. For this reason, successful SME engagement requires special measures that can be derived from three approaches. Value network approach drives SMEs to participate, providing them tangible incentives and a way to assess how the participation can improve their business. Communicative interface helps to raise awareness and connect the right SMEs to right opportunities. Finally, positive discrimination enables the SMEs to participate, lowering the barriers to match their limitations.

The variety of SME means they can and should be able to take different roles in the R&D projects. Although it is useful to recognize the main types of SMEs, there is no need to implement strict categorization within the R&D support scheme, but instead let SMEs identify the opportunities, roles and programmes they find interesting. Same goes for strict, formal requirements. If the interface the SMEs face works, they should be able to assess which of the programmes and projects are suitable for them and the evaluation process should then filter the best companies to participate.

Change is needed in all levels, but the frame on the European level is set by the rules of the Framework Programme. Although any significant changes will have to wait until the Horizon 2020 starts, a lot can be done also within the FI PPP level to improve SME involvement. Bigger structural changes based on the positive discrimination approach – such as enabling associated partner role – are out of the scope of the PPP, but many other measures stemming from the three approaches could well be utilized in the current or the later phase. FI PPP has the elements to success in SME engagement. The partnership is coordinated and flexible. What is most needed now is clarification of the mission and more concrete goals.

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Appendix A: List of the Interviews

The sixteen interviews were conducted 2.11.2011 – 13.1.2012. The following list presents the interviewees, time and arrangements of the interviews:

- Ulla Hytti, Turku University School of Economics, 2.11.2011, face-to-face
- Jari-Pekka Kaleva, European Games Developer Federation EGDF, 9.11.2011, face-to-face
- Jaakko Salminen, The Finnish Software Entrepreneurs Association - Ohjelmistoyrittäjät, 14.11.2011, face-to-face
- Otto Hiilka, Flowdock, 15.11.2011, face-to-face
- Dr. Terttu Luukkonen, The Research Institute for Finnish Economy ETLA, 16.11.2011, face-to-face with fellow researcher Tuuli Hakkarainen
- Karin Wikman, The Finnish Funding Agency for Technology and Innovation Tekes, 22.11.2011, face-to-face
- Juhani Lempiäinen, Deltatron, 2.12.2011, face-to-face
- Paul Houghton, Futurice, 7.12.2011, face-to-face
- Janica Ylikarjula, Confederation of Finnish Industries EK, 9.12.2011, face-to-face
- Prof. Arturo Azcorra, IMDEA, 13.12.2011, telephone
- Janne Koivisto, Helsinki Chamber of Commerce, 20.12.2011, face-to-face
- Dr. Leena Sarvaranta, VTT Technical Research Centre of Finland, 3.1.2012, face-to-face
- Prof. Dr. J. Rod Franklin, Kuehne + Nagel Management AG, 4.1.2012, telephone
- Prof. Sjaak Wolfert, Wageningen University and Research Centre (WUR), 5.1.2012, telephone
- Pekka Krook, Diges ry – National association for developing the creative industries in Finland, 12.1.2012, face-to-face
- Dr. Werner Mohr, Nokia-Siemens Network, 13.1.2012, telephone

Appendix B: Interview questions

In the empiric study, the following set of questions was used as the basis for semi-structured interviews. The set was developed as the interviews progressed, and this shows the final set of questions. In most cases some customizations according to the role of the interviewee were also made. In five of the sixteen interviews, there were more significant modifications, but in general the same topics were discussed,

PART I: Background

1. What is your background and experience related to the topic?
2. What is the role of your organization / enterprise regarding the topic?

PART II: SME engagement in general

1. General view towards EU funded R&D efforts? Are there or have there been some trends or changes in the past or ongoing now?
2. Why should SMEs be involved in EU's R&D projects and programmes, or should they?
3. What possible roles do SMEs have in collaborative R&D projects?
4. Should SMEs be viewed mainly as providers or exploiters of R&D?
5. Who is typically taking the initiative in R&D projects? How are the SMEs found in the projects?
6. What are the most relevant barriers for participation?
7. What are the main reasons not to participate?
8. What are the most important incentives to participate?
9. What do participating SMEs benefit from participation?
10. Are there any perceived problems in SME engagement? Misuse of funding, incentives that push into wrong direction?
11. Are SMEs in general technology or market oriented participants?
12. Which is more important: the benefit for the project or the benefit for the SMEs?
13. Is it enough to gain knowledge, reputation or network related benefit? Should the directly business related indicators be emphasized?
14. Division of roles between national and EU R&D support? Is there a need for clearly defined division of roles?
15. Should public funds be used to support near-market R&D?
16. How should SME engagement be measured?
17. How do SMEs differ from large companies?
18. How do the mechanisms in the EU differ from other regions? Good places to benchmark?
19. Is the public-private partnership a clear concept?

PART III: Different SMEs

1. Is the current SME definition valid?
2. Should the sub-division (micro, small, medium) be emphasized more? Or less?

3. How should the SMEs be categorized from R&D perspective?
 - a. R&D capabilities and attitude?
 - b. Industry sector?
 - c. Technology vs. market orientation?
4. What can a non R&D-oriented company gain from collaborative projects?
5. What is the role of growth companies in R&D collaboration?
6. Do growth companies have some special needs and how should they be catered?
7. Is there need to focus? If so, what kind of companies should be focused on?

PART IV: Policy recommendations and measures

1. Which is more important form of public support to encourage R&D in SMEs: direct project funding or indirect support like fiscal incentives?
2. How could SME networks and associations be utilized? What are the most important ones?
3. What are the best ways to market the opportunities to SMEs? Best media?
4. Comments on suggestions:
 - a. Two-stage application process
 - b. Shorter, smaller projects
 - c. Cutting red tape, decreasing bureaucracy
 - d. Engaging SMEs in design, planning and evaluation
 - e. Extra support for commercialization at the end of the projects
 - f. Improving payment conditions
 - g. Higher funding rates (now 75%)
 - h. Improving communication and dissemination
 - i. Smaller project consortia
 - j. Co-operation with private investors (venture capitalists and business angels)
 - k. More open project calls (topics)
 - l. Training project officers on SME needs and challenges
 - m. Training other stakeholders on SME needs and challenges
 - n. Training SMEs
 - o. Enabling SME participation in later stages of a project or just part of the project
 - p. Enabling SME participation in groups or clusters
 - q. Improved IPR protection
 - r. Supporting customer creation, involving public or private procurement or matching supply and demand
 - s. Peer-review as part of participant review

PART V: Advice

1. How well can a study with a Finnish bias be generalized to European level? What aspects or special characteristics should be taken into account?
2. What are the key organizations or actors that should be approached for this study?
3. Can you suggest any contacts to interview? Any relevant material that should be reviewed?
4. Other advice?