European Commission

Innovation

How to convert Research into Commercial Success Story?

Part 1 :
Analysis of EU-funded research projects in the field of industrial technologies

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Research and Innovation

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Part 1: Analysis of EU-funded research projects in the field of industrial technologies

This study was carried out for the European Commission by

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Executive Summary

The overall aim of this study was to retrace the pathways and analyse the impact factors of successful commercialisation of EU-funded R&D projects in industrial technologies. To this end, the research team analysed more than 40 cases of commercialisation processes based on projects funded by the European Framework Programmes 4-6.

As the reality of organisations and individuals creating positive effects for themselves – and ultimately the European economy as a whole – based on research outcome turned out to be rather complex and multifarious, it became evident that the term ‘commercialisation’ was no longer appropriate. *Since commercialisation is often understood as the direct, immediate conversion of research into economic success the research team switched to the concept of (successful) market-oriented exploitation, i.e. any exploitation of research outcome that contributes to a positive economic effect for the organisations involved.* In general, there is an immense variety of forms of positive economic effects based on research outcome and an equally large variety of (path-) ways to get there.

Consequently, two main types of pathways were identified. For very few cases a direct and almost linear conversion of research outcome into a commercial success was actually found. They managed to *convert* their research in a very direct, linear way into a product or service available to the market without including major additional development steps. However, for the majority of cases the organisations and individuals involved in the market-oriented exploitation process had to put substantial additional effort into *transforming* their research outcome into a commercially relevant and available product or service. Thus, their pathways to market-oriented exploitation became rather non-linear and complex as they were affected by technological set-backs, feedback loops with other (parallel) innovation or R&D projects etc.

Apart from retracing the pathways of market-oriented exploitation, the study at hand set out to identify and analyse the impact factors (obstacles overcome and challenges met) of such pathways of market-oriented exploitation; in their entirety often referred to as the ‘valley of death’. *It turned out to be most relevant and necessary to differentiate the technological from the commercial valley of death.* While the valley of death does indeed exist for EU-funded R&D projects, the market-oriented exploitation processes analysed by the study at hand in most cases managed to bridge the former they often struggled with the latter, i.e. finding an avant-garde customer who provides a first return-on-investment and signals the feasibility of a technology to more risk-averse customers is crucial for the success of commercially exploiting research outcome.

Altogether, some 50 impact factors were identified as affecting the success of market-oriented exploitation processes ranging from the type of research conducted, the composition of the original research consortium, management and governance of research and exploitation processes to international competition, standardisation and regulation. *The most effective of these impact factors is – not surprisingly – market pull. Furthermore, there is no successful market-oriented exploitation if the framework conditions are not favourable.* While organisations and individuals involved in market-oriented exploitation processes do not have much control over market pull or the framework conditions (and other related impact factors such as the global economic climate or customers’ investment cycles), *there is still a lot that can be done to optimise the market-oriented exploitation and limit the risks along the way.* This includes a variety of structural, strategic or behavioural elements such as composing a research or market-oriented exploitation consortium including SMEs as fast-moving, niche-seeking organisations, large enterprises with their market power, customers possibly acting as avant-garde purchasers; develop and act upon R&D and exploitation strategies in a flexible manner; establish market awareness as a guiding principle, identify market needs but avoid limiting economic (application) range by blanking out opportunities beside these needs.

Consequently, *there are a number of access points for public support aiming for increased and improved market-oriented exploitation of publicly funded R&D projects.* Despite the evidence for converging policies being rather limited, RDTI policies tend to focus on the following issues: *lack of market pull for innovative technologies, difficulties in transforming research outcome into innovations, and lack of entrepreneurial activities resulting from publicly funded research. In general, there is a trend towards the general diversification of support mechanisms beyond funding (i.e. co-financing) of collaborative research projects in either thematically specified or open funding programmes.* Gap funding and means to support bridging the valley of death not covered by co-financing collaborative R&D projects is increasingly common. The main policy trends seem to generally comprise a changing overall approach to support mechanisms. RDTI policies are increasingly using support 'systems' instead of individual collateral funding schemes providing the chance to have one's research idea or concept being supported all the way through the innovation cycle. All in all, successful market-oriented exploitation of research outcome is a very complex issue with a wide variety of impact factors shaping the pathway from R&D projects to positive micro- and macroeconomic effects. *Public support systems – although being sensitive to and aware of this complexity – cannot be tailor-made to fit individual R&D projects or organisations.*

Nevertheless, there are modifications of existing RDTI policies that will help to increase the potential for and likeliness of successful market-oriented exploitation of publicly co-financed research. *Firstly, funding organisations and programmes need more flexibility* because projects and commercialisation pathways are not uniform. This includes more room for manoeuvre for both the funding itself and the funded organisations within the legal framework provided by funding guidelines etc. *Secondly, management capacities and capabilities of consortiums and organisations* – i.e., their ability to strategically manage impact factors and the complex interaction of organisational, cultural and individual factors – *need to be strengthened.* To this end, requirements should be raised to 'force' organisations to develop management strategies and routines for day-to-day business as well as likely challenges, risks and emergencies. Furthermore, fulfilling these requirements should be enforced through various means. *Thirdly, in order to create and increase the economic leverage of public R&D funding and to safeguard the investments made with taxpayers' money through funding additional activities should be implemented*, from entrepreneurial training measures for researchers to evaluating the performance of project coordinators. These main principles for an improved support of R&D projects in their aim to achieve successful market-oriented exploitation led to a number (23) of practical policy recommendations.

Against the background of the study as a whole, the following recommendations' implementation is considered being especially important with regard to an increase in commercially relevant effects of publicly funded R&D projects:

With regard to the evaluation of proposals, the projects should be divided into at least two groups: (1) rather basic research and (2) rather applied research (it might be *reasonable to ask the applicants to specifically develop their proposal for one type of project ex-ante). Consequently, the evaluation criteria 'scientific excellence' and 'commercial impact' will have to have different relevance. Still it is very important to have both groups of research projects funded as commercial conversion goes hand in hand with scientific excellence in the building of new markets.*

Risk and emergency management plans for the most likely critical/emergency situations should be mandatorily developed for every research proposal. Consortia should be obliged to analyse and disclose (in their proposal) the most likely risks and develop strategies to deal with these.

Allow projects that were identified or turned out as high-impact projects or projects whose research outcome will likely produce or contribute decisively to disruptive technologies to be supported throughout the whole innovation cycle, i.e. not necessarily only using funding. The support should be coordinated among all potential supporters (e.g. DGs, ERC, national funding agencies etc.) and be based on integrating RDTI policies with demand- and supply-side policies. The additional support could also take the form of prize money, which could extend publicity and thus create additional exploitation possibilities. All of this should limited to the 'elite' projects.

Consider the establishment of a monitoring mechanism (at EC level for research fields and/or project level for individual issues) for accompanying projects with regard to the identification of regulations or standards or norms or public opinions that may hinder or prevent the eventual market-oriented exploitation. The importance of this issue may depend on the type of research (and may not be necessary for strong basic research projects).

Include pre-commercial procurement as a means to complete market-oriented exploitation processes by creating demand.

INTRODUCTION

In an era of ever-growing global socioeconomic competition, Europe is facing constant challenges of its overall competitiveness. The need for growing sustainability, reduced energy consumption, meeting societal demands etc. are among the core drivers for policies and the question of how to spend tax payers' money effectively, efficiently and to the benefit of Europe's societies. As part of the current Europe 2020 strategy[1] – developed by the European Commission and published on 3 March 2010 – the stimulation of the economy of the European Union consequently needs to focus on smart, sustainable, and inclusive growth. Research, technology and innovation are seen as crucial elements of this strategy and its aim to safeguard future socioeconomic prosperity by building the knowledge base of the European economy, creating sustainable jobs for highly qualified personnel, developing answers to societal needs and demands. To this end, all elements of the knowledge or innovation chain, from basic research to successfully marketing innovative products or services, have to be strengthened as do their interfaces.

However, there is the so-called 'European Paradox'[2]. The term was coined to describe that Europe is apparently lagging behind North America and the developed countries in East Asia when it comes to transferring research outcome into innovation and economic success despite a comparable, and in some areas leading, scientific performance. Without entering a comprehensive discussion of the issue, it should be noted that there is also evidence for the 'European Paradox' becoming less and less an exclusively European but a more global problem, or in fact an increasingly regionalised issue as suggested by findings on different countries or research fields. Furthermore, some studies have argued that this is in fact not a paradox at all since Europe is lagging behind in scientific output as well.[3]

Against this backdrop, Europe 2020 states the following main goals under its flagship initiative 'Innovation Union':

- To complete the European Research Area, to develop a strategic research agenda focused on challenges such as energy security, transport, climate change and resource efficiency, health and ageing, environmentally-friendly production methods and land management […];
- To improve framework conditions for business to innovate […];
- To launch 'European Innovation Partnerships' between the EU and national levels to speed up the development and deployment of the technologies needed to meet the challenges identified […] to shape Europe's industrial future' and 'technologies […];
- To strengthen and further develop the role of EU instruments to support innovation […];
- To promote knowledge partnerships and strengthen links between education, business, research and innovation, including through the EIT, and to promote entrepreneurship […].

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1 European Commission (Ed.)(2010): Europe 2020. A strategy for smart, sustainable and inclusive growth, Brussels.
2 Andreasen, Lars Erik (1995). Europe's next step: organisational innovation, competition and employment. London.
3 European Commission (Ed.)(2011): Innovation Union Competitiveness report 2011, Brussels.

The European Framework Programmes as the EU's main channel for innovation-related funding and support will have to increase their contribution to and positive impact on these issues. While the support of frontier basic research is undoubtedly the basis for every innovation and innovation-related socioeconomic prosperity, the European Paradox reveals the policy field with the most leverage: supporting the transformation of research outcome into successful marketed products and services. Therefore, the research objective of the study at hand was to identify and analyse how different EU-funded projects (i.e. projects from the 4^{th}, 5^{th} and 6^{th} Framework Programme) in the area of industrial technologies (nanotechnologies, new materials and production processes) were successfully transformed into marketable innovations. In order to support the improvement of public support system provided by the Framework Programmes, the research team had to identify and analyse the framework conditions and impact factors of such success stories, the chain of events and actions that created them, the obstacles overcome and how they were overcome. Based on the results, the ultimate goal was to develop recommendations based on the lessons learnt.

To this end, the study at hand was tendered to deliver findings on the following three main issues.

Analysing pathways from research outcome to successful commercialisation: in the context of commercialisation of EU-funded research, the development of a specific research outcome to such an extent that it reaches the market place is in itself a successful commercialisation (see also chapter 4.1). Hence, the market success of a product, or ranking the relative successes of different products sprung from EU-research, did not lie within the scope of the study. The analyses focussed on the description and analysis of the different steps of selected cases on their way towards the market. There is huge variety of pathways, differing from project to project. Some pathways have been on-going across more than one Framework Programme before market entry has taken place, while others were successfully completed within a few years.

Detecting factors of success and failure to market entry: the focus of the study is on decisive impact factors that have supported or hindered entry to the market. Such factors range from the personal motivation of individuals in a research consortium, the ability of the consortium to agree on critical issues such as IPR, the contacts and collaborations with relevant external research and non-research actors (financial, legal, entrepreneurial etc.), as well as how problems relating to working in projects with partners over vast distances have or have not been overcome.

Developing recommendations to facilitate the transition from research to innovation and the market: this study will produce a range of concrete recommendations. These will relate to the different steps and stages in the transformation from research to innovation and market related activities as well as a range of potential pitfalls that must be avoided in order to increase the probability for commercialisation.

Study design and methodology

1.1. *Overall design*

The general design of the study at hand was organised along four different main modules that included a number of work packages and research steps in order to cope with the complexity of the issues investigated as well as to allow for a feedback-based learning system approach. Figure 1 represents this research design and the interactions and feedback loops between the different modules of the study.

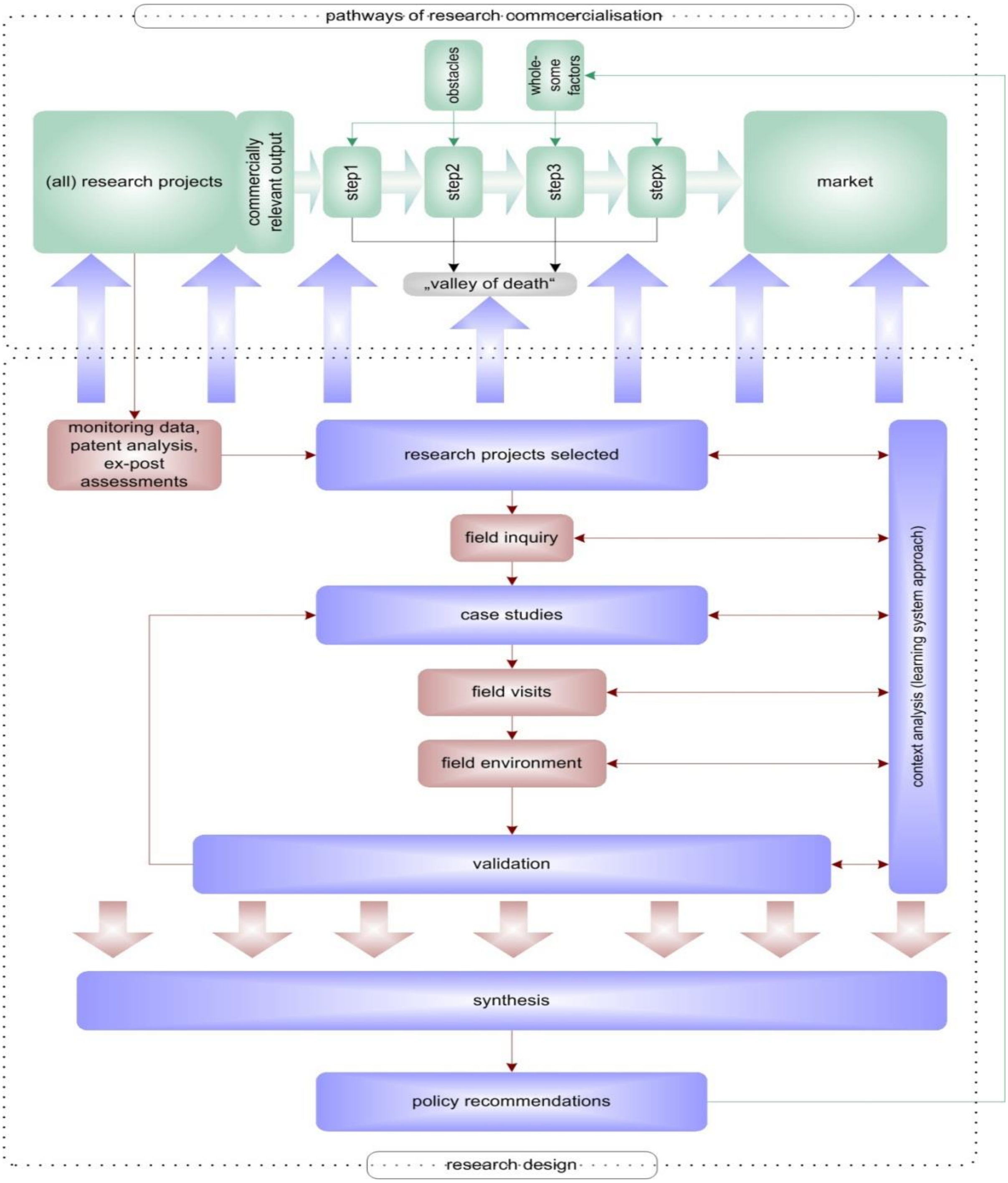
In preparing the analysis of pathways from R&D projects to successful market-oriented exploitation, the research team developed hypotheses on impact and success factors and their effect on market-oriented exploitation based on literature and other publications as well as through exploratory interviews with selected experts. These hypotheses were developed into an interview guideline for qualitative, narrative interviews with representatives from organisations involved in market-oriented exploitation processes selected as case studies (for details on the development of the guideline see chapter 3.3, and for the selection process see chapter 3.2.)

Before conducting interviews, the research team carried out a field inquiry that was designed to identify potential interview partners from different R&D projects (for details see chapter 3.2); a research step necessary due to the lack of appropriate monitoring data from the European Commission, especially for Framework Programmes 4 and 5.

The interviews were conducted predominantly as face-to-face interviews during field visits, i.e. visits from at least one researcher at the facilities of the organisations selected as (part of) a case study. Depending on the number of individuals involved in the market-oriented exploitation processes, these interviews included up to six interviewees per field visit (either in a group interview or in successive interviews). Wherever possible and needful, the research team conducted additional interviews (to analyse the 'field environment') in order to elucidate aspects or processes not fully covered during the field visit. These interviews were primarily conducted via phone.

In order to validate the preliminary findings on impact and success factors as identified by qualitative interviews, the research team conducted a validation survey among participants of R&D projects in industrial technologies funded under Framework Programmes 4-6. The results of this survey were not only used to weight the effect of different factors but also as a feedback to the on-going fieldwork, i.e. results that challenged certain mechanisms and impact factors identified prior to the validation survey were tested by means of additional interviews (case studies). Thus, the research approach provided a system of double checks with regard to the results that were used for the final analyses and syntheses.

FIGURE 1 RESEARCH DESIGN



Source: Austrian Institute for SME Research 2011

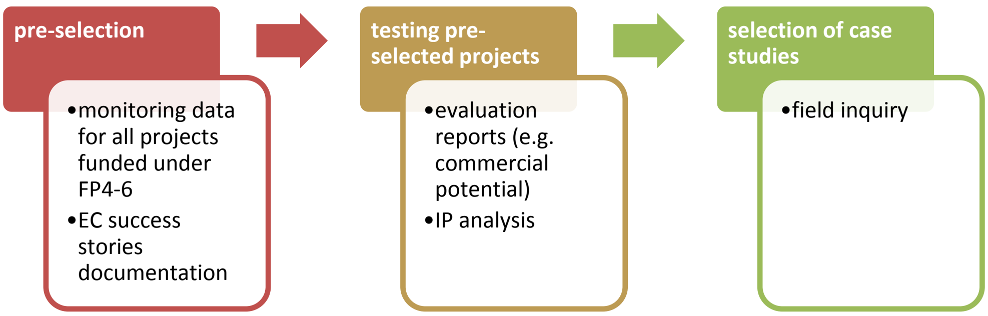
1.2. Selection of case studies

With regard to the sample of projects (and ultimately, case studies) the European Commission and the research team agreed to apply a different methodology for each of the three Framework Programmes investigated against the backdrop of differences in available data. Since a perfect balance of any kind (with regard to a multitude of potential balancing criteria) is close to impossible, the case study selection criteria were established as follows: at least 5-10 case studies were to be selected from FP4 and case studies from FP5 and FP6 would constitute the majority of case studies. An approximate balance between each of the three industrial technologies (nanotechnology, materials and production processes) should also be aimed for. Furthermore, it was agreed that the database should include an approximate balance of projects with project managers from the different EU Member States, different organisation types, with regard to project size and duration. However, the selection of case studies was ultimately based on the completeness of responses to the field inquiry (i.e. number of responses per project).

The selection process contained three main steps:

- *Pre*-selection of *R&D projects* based on monitoring data
- *Testing* pre-selected *R&D* projects based on additional information gathered from evaluation reports and an IP analysis
- *Selecting case studies* (organisations and individuals) actively involved in market-oriented exploitation processes based on responses to a survey (field inquiry)

FIGURE 2 SELECTION OF CASE STUDIES (PROCESS)



Source: Austrian Institute for SME Research 2012

In the course of the first stage of the research project, the research team has been provided with monitoring data of EU-funded R&D projects in industrial technologies from the Framework Programmes 4, 5 and 6. The data consisted mainly of extracts from database entries, containing basic information about the projects' objectives and partners, budgets, timelines and contact information. The amount and scope of data available led to modifications in the original plans of data matching and preparing these data for the selection processes.

The main objective of the pre-selection of projects was to build a database that would feed into the intellectual property analysis as the main instrument of selecting potential case studies. In order to be able to arrive at a final sample of 40-45 case studies, it was necessary to have a certain number of back-up projects (and potential case studies). Hence, it was decided to develop a first project sample of approx. 100 projects.

Because the data varied considerably in completeness, richness and consistence across the three Framework Programmes, especially with regards to potential pre-selection criteria, different approaches had to be developed to select cases from each FP for further analyses.

For projects from FP4, the research team pre-selected 15 projects based on the European Commission's success story documentation that was originally based on the projects' scientific and technological relevance for the area of industrial technologies. The project pre-selection for FP5 was based on the meta-analysis of the EVIMP2 ex-post evaluation, i.e. projects that received a high or very high rating with regard to their 'current exploitation level', 'exploitation potential' and 'prospect of reaching potential' (in total 62 projects). Projects that scored 'low, 'moderate' or 'medium' in at least one of the three assessment criteria were eliminated as were projects with missing entries. The number of cases was further reduced to 35 (including seven projects that were additionally flagged as success stories by the European Commission) by applying the above-mentioned balance criteria and including the comments taken from the EVIMP2 report.

The first step of pre-selecting projects from FP6 was based on their assessment regarding their 'use potential' as included in the monitoring data (in total 69 projects were regarded as having a high 'use potential'). On that basis, a smaller sub-set was selected, by balancing the final sample of 50 projects along different balance criteria such as N/M/P split, instrument type, project duration and costs (and EC contribution), number of partners and country of the project managing organisation.

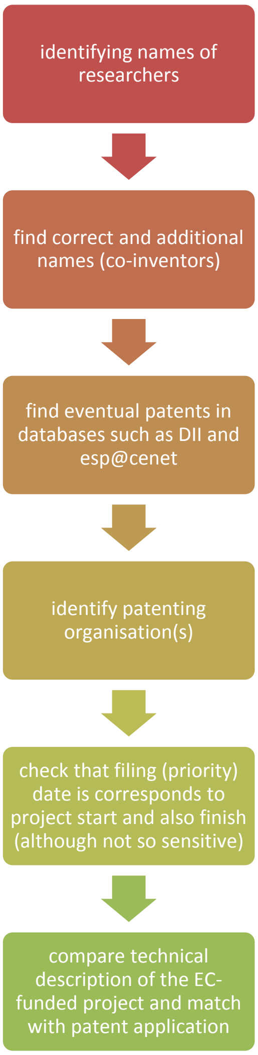
In order to arrive at a final set of potentially interesting R&D projects, on which the selection of case studies had to be based, the research team consulted additional documents about European Framework Programme success stories and evaluation reports such as the EVIMP2 report and the respective meta-analysis.

The analysis of IP (both filed and granted) was based on the assumption that intellectual property rights are fundamental to NMP innovation – and therefore, the commercialisation of associated research results – also in the future, although the way of perceiving and using them may change in the light of more open innovation. Without entering into the general – growing – discussion of the value and relevance of patents, the research team would like to acknowledge the following issue: Patents are often regarded as *the* indicator of technological innovation par excellence. However, a granted patent merely indicates the existence of novelty and an inventive step, and not necessarily successful commercialisation; many patents remain unutilised throughout their lifetime without having been part of any commercialisation attempt, while others for a variety of reasons are part of failed exploitation efforts in spite of existing motivation to commercialise. If novel research results are instead published – without first filing a patent application – they will instantly form part of the public domain and what is called prior art, which means that the primary patentability criteria, that of novelty, is lost. Under certain conditions organisations and individuals choose not to disclose inventions to the public. Reasons for this vary. One important motive is the fact that technologies – some more than others – are prone to copying and circumvention. That is, the detailed, publicly available description of a technology in a patent could inspire others to come up with competing, more cost-efficient solutions. Actors could for this reason opt to keep commercially valuable information secret. Indeed this method of protecting innovations through 'trade secrets' remains one of the primary methods to prevent technology being copied, and as such patenting will always be a proxy indication of innovation rather than an definitive one.

The primary selection solely had a qualitative basis, while the secondary selection threshold consisted of a requirement, which would give a binary response to the question if there were patent applications filed or other attempts of protecting intellectual property (mainly under trade secrets, trademarks, and copyright laws). The IP analysis had an exploratory nature and should not be taken to be exhaustive, as a thorough investigation of potential intellectual property rights created in all industrial technologies projects funded under FP4-6 would have been an extremely complex and time-consuming task.

The IP search process was conducted along the following six research steps:

FIGURE 3 IP ANALYSIS (PROCESS)



Source: Austrian Institute for SME Research 2012

It was possible to identify patent applications in a majority of the 44 pre-selected projects (and a minority were chosen as they referred to or seemed to have created software); 10 from FP4, 16 from FP5, and 18 from FP6. A preliminary hypothesis is that FP6 did not to the same extent as the previous FPs aim at direct technological innovation, but also at organisational and value chain innovation, building European-wide technology platforms and the creation of the European Research Area (ERA). Projects qualified only in cases where there was a clear match between the project description and the subject matter of the patent application, as some organisations have extensive patenting activities across many technology platforms.

For the vast majority of patent applications with more than one inventor, the co-inventors came from within the same organisation. Only a fraction of the analysed projects with identifiable IP had co-inventors from different organisations. Thus, it remains unknown in many cases to what extent research collaboration took place across participating organisations in the projects. Industrial actors were most active in filing patent applications, and also public research institutes were quite active. Academia was only represented to a much lower degree.

The 3rd and final step in the process of identifying case studies comprised a short survey (field inquiry) among the coordinators and partners of the pre-selected projects. The field inquiry was implemented as an online survey in the beginning of December 2011. The participants of the pre-selected projects were asked to answer the following questions within the field inquiry:

Table 1 Content of field inquiry

		Questions	Answers
	1	To your knowledge: which stadium / stage did the commercialisation process of the aforementioned research project reach until now?	• publication • patenting • licensing • demonstration • prototype • product development • product available on the market
	2	To your knowledge: which of the following exploitation/commercialisation outputs did the research project produce?	• patent • licensing agreement • product • spin-off • in-house processing of research results • other
	3	Were you / was your (former) organisation involved in the commercialisation of the research outcome of the funded project?	• yes • no
if 3 = yes	4	Would you be willing to participate in the study (i.e. participating in interviews)?	• yes • no
if 4 = yes/ no	5	Did you cooperate with other organisations outside the original research consortium in the course of the commercialisation process?	• yes • no
if 5 = yes	6	Please name the most important organisations you cooperated with and, if possible, the name and position of the person responsible.	• open list

Source: Austrian Institute for SME Research 2011

The field inquiry was answered by 170 individuals from a total of 65 different R&D projects. Although the vast majority of these 65 R&D projects would have qualified as a case study (based on the information given by the respondents on commercialisation stage and outputs of the project), the finalised database of case studies contained 53 individuals (who stated that they and their organisation have been involved in the commercialisation processes in question, which was a prerequisite for the case study interviews), representing a total of 39 R&D projects. As for the total number of case studies, the research team expected that at least some R&D projects led to more than one (independent) commercialisation process, which would result in a number of case studies higher than 39. A major issue for the balance of case studies across the three Framework Programmes 4-6 was the fact that responses for FP4 and 5 are largely underrepresented. The main reason for this is that most of these projects were concluded a comparably long time ago, i.e. people responsible have left the organisations (especially companies) in question, organisations (again, primarily companies) have been sold, went bankrupt or were re-organised extensively leaving no trace of the R&D project and its outcome or the commercialisation processes. Thus, FP 6 formed the vast majority of case studies.

1.3. Interviews

The collection of information and data from selected case studies was primarily based on qualitative interviews. As laid out in the original tender, the main interview(s) (i.e. organised as one group interview or subsequent interviews with different individuals) forming the central information source for each of the case studies were (a) narrative one(s). This methodology had been selected to produce added value to an otherwise rather well-researched field by focussing on qualitative information and 'stories' of commercialisation pathways (thus, not focussing on aspects of commercial success referring to marketing, pricing etc.). Whenever feasible the research team interviewed all representatives from each organisation who were responsible for and involved in the R&D project and its market-oriented exploitation; in some cases in subsequent interviews and often as a group. Following the face-to-face interviews, additional interviews were conducted with individuals who had additional information available. Usually, these individuals were nominated by the people interviewed face-to-face. The additional interviews were primarily conducted via telephone.

All interviews were conducted using a guideline, which was developed during the early stages of the project on the basis of a comprehensive, all-embracing collection of relevant issues, impact factors and hypothetical correlation and causalities. The first step of the guideline development was based on an extensive literature research, combining approx. 80 different publications (relevant academic literature, evaluation studies, EC publications, OECD documents and other web-based materials in the field of research and technology commercialisation). The identification of relevant information sources was primarily based on two web-based databases for academic resources: EBSCO and LIBRARY.

The literature was systematised and grouped as follows (a full reference list can be found in the annex of this report):

- Academic Books
- Academic Articles
- PhD Dissertations

- EC Documents
- OECD Publications
- Additional material

The survey of the literature was conducted using an analytical software tool that allows an effective survey of large numbers of documents, as well as coding and systematising relevant content identified. Building on the literature, the research team developed a number of hypotheses aiming for:

- the identification of potential impact factors for success or failure in the process of commercialisation of research outcome, and
- the development of hypotheses regarding the identified impact factors and their effect on commercialisation processes.

Firstly, a list was developed that provided the impact factors identified, their theoretical (i.e. literature-based) relation to commercialisation and transfer of knowledge – in the form of 'if... then...' or 'is likely to...' hypotheses – as well as a short description and/or explanation and the source. As a preliminary result this first step produced a total of 44 relevant impact factors and hypotheses along the different stages of an innovation process. In order to provide the study with a traceable and easy-to-process feedback from the research team's expert group, the full list of impact factors and respective hypotheses were transformed into a table that did not only allow for additions and comments from these experts but also to incorporate their assessment of:

- the relevance of the different hypotheses for industrial technologies as such,
- the sub-areas of industrial technologies (i.e. nanotechnology, materials and production processes), and
- the specific context of EU-funded research projects (assuming that EU Framework funding might attract a specific type of research projects).

This exercise also included comments explaining the experts' assessment as well as their reasons for adding or dismissing hypotheses and brought the total count of impact factors to 75 and by reducing overlaps etc. to a final 62 impact factors / hypotheses. These were subsequently transformed into the backbone of interview guidelines for the field work stage of the project. The full collection of questions used for the interviews can be found in the annex to this report.

The basic interview structure that the research team developed and applied to structure the stories told by the interviewees contained three different stages:

- Description of the chronological sequence of events and actions that defined the commercialisation process along the graphic representation (illustration)
- Identification of the most crucial steps, phases, events or actions that were decisive for the commercialisation process
- Detailed questions referring to those steps, phases, events or actions that were decisive for the commercialisation process (supported by the set of hypotheses and impacts factors developed during the inception stage of the study)

The research team kept handwritten minutes of the interviews that were condensed, transformed into a homogenous format and exchanged. Some interviews were additionally recorded, and the transcripts were used to complete the interview minutes.

During the interview the interviewees were asked to draw a technology transfer/commercialisation flow chart in order to provide the research team with a figurative representation of the actual path of the technology/product to the market, serving as both an opening for the interview (by recalling different actors, factors and processes) and a reference point in the story telling during the interview. It was also used to identify and 'locate' different actors, factors and processes that played a crucial and important role in each of the cases. In addition to the interview minutes, these flow charts were used to identify patterns and types of pathways.

1.4. Validation survey

The study design included validating the preliminary results from the different case studies as an intermediate step halfway between fieldwork and analytical work / synthesis. Contacting and approaching all participants (project coordinators and partners) of projects funded by NMP in FP 4, 5 and 6 was based on the information obtained from the European Commission's databases. The survey was designed and implemented as an online survey to ensure its accessibility. The questionnaire was based on preliminary findings. The analysis included standard methodologies of empirical social and economic sciences, e.g. analysis of frequencies, mean values, percentages etc. The online survey was sent to 1,178 contacts of which 221 invitations were undeliverable due to various reasons (e.g. incorrect addresses, security settings). Out of the remaining 957 possible respondents 174 answered the questionnaire, whereof 138 were useable for a continuative analysis. Thus, the effective response rate added up to 14.4 %.

The vast majority of the respondents (93 %) participated at least in FP6 whereas the replies for FP 5 (53 %) and FP 4 (24 %) are significantly lower. More than 50 % of the participants have been involved in only one Framework Programme while 21 % of the respondents participated in all three Framework Programmes investigated. Both small and medium-sized enterprises (SME) and higher education institutions (HEI) account for 27 % (in absolute numbers: 36) of the respondents. 25 % (in absolute numbers: 34) of the respondents were research organisations (RO) and 20 % (in absolute numbers: 27) were large enterprises (LE). Less than 2 % of the respondents were other organisations.

The lion´s share of respondents are predominantly active in developing production processes: 46 % (in absolute numbers: 63) of the participants are focussing on this area of research, while 27 % focus on materials and another 25 % on nanotechnologies. However, the interviews indicate that projects in applied research are much more easily exploited in a commercial sense. Of the three options – nanotechnologies, materials and production processes – the latter is closest to application, which significantly increases the likelihood that participants of such projects would be able and willing to answer the questionnaire.

Around 87 % of the respondents stated that market-oriented exploitation is very important or rather important. In general, the relevance is highest for commercial organisations and decreases with the general relevance of any commercial activity.

For the actual questionnaire, the research team transformed the main preliminary results into questions about the 'mode of action' of different impact factors. Thus, each of the most relevant impact factor and its main 'modes of action' were transformed into statements for which the respondents were asked to indicate their level of agreement/disagreement (see annex). While the larger part of the questionnaire contained ordinal scaled response categories for measuring the level of agreement to the statements regarding different success and impact factors, the initial four nominal scaled questions were designed to disclose the respondents' main affiliation and other indicators that could impact their responses. In addition, these questions were used to control the responses for potential biases.

1.5. FIELDWORK REPORT

The fieldwork – consisting of face-to-face and additional telephone interviews with representatives of organisations involved in EU-funded R&D projects and the market-oriented exploitation of the outcome of these projects – was completed by end of September 2012. The following table displays projects and case studies investigated, with some projects supplying more than one case study.

TABLE 2 CASE STUDIES INVESTIGATED

Project (acronym)	FP	Instr.	NMP-split (or equivalent)	number of case studies per project
AFFIX	6	IP	NMP-3	1
AL-MOULD	5	-	5- New materials and their production and transformation (including steel)	1
ALTEX	6	-	non-NMP project	1
AMBIO	6	IP	NMP-1	1
CDTreatment	5	-	1- Innovative products, processes and organisation	1
CONTEX-T	6	IP	NMP-4	1
DINAMICS	6	IP	NMP-4	1
DIPNA	6	STP	NMP-5	1
EURO ShoE	5	-	1- Innovative products, processes and organisation	1
EUROLIFE-FROM	5	-	1- Innovative products, processes and organisation	1
GAPOGROWTH	5	-	5- New materials and their production and transformation (including steel)	1
HOLIWOOD	6	IP	NMP-3	2
INMAR	6	IP	NMP-4	2
INSIDE_PORES	6	NoE	NMP-1	1
I-SSB	6	IP	NMP-4	1
I-STONE	6	IP	NMP-3	1
LAUNCH-MICRO	6	IP	NMP-3	1
LEPOCUT	4	-	-	1
MY-CAR	6	IP	NMP-3	1
NADIA	6	IP	NMP-4	1
NANOBIO-PHARMA-CEUTICS	6	IP	NMP-1	1
NANOCMM	6	IP	NMP-3	3
NANOGLOWA	6	IP	NMP-2	1
NANOKER	6	IP	NMP-2	1
NEPUMUC	6	STP	NMP-3	2

NEWBONE	6	IP	NMP-4	1
SAFEPIPES	6	STP	non-NMP project	1
SINPHONIA	6	STP	NMP-4	1
SUSTAINPACK	6	IP	NMP-2	2
SWOP	6	STP	NMP-4	3
TEM-PLANT	6	STP	NMP-1	1
XPRESS	6	IP	NMP-3	1
Total number of case studies				**40**

Source: Austrian Institute for SME Research 2012

There is a bias in the selection of case studies towards the 6th Framework Programme as only one case study stems from the 4th and another five from the 5th Framework Programme. The primary reason is that more detailed contact data were provided to the research team for FP6 than any other Framework programme.

The main challenge with the fieldwork conducted was naturally getting in contact with representatives of organisations involved in R&D projects and their exploitation. A second challenge was to convince them to take part in comparably long face-to-face interviews. Some contact persons had left the organisation in question, and in some of these cases no individual could be identified that was involved in the processes investigated. In other cases, the contact persons had ‘worked their way up’ internal hierarchies making them almost impossible to reach/interview. Some of the latter had to be interviewed by telephone instead of a face-to-face interview. However, the research team is convinced that the quality of information obtained did not suffer from these circumstances.

FINDINGS AND RESULTS

The following chapters represent the findings and results based on the fieldwork conducted. However, it is the research team's conviction that before entering into any discussion of findings, results and ultimately, conclusions the study's main objective of identifying and investigating successful commercialisation of research projects needs to be framed by discussing what success actually is and whether or not commercialisation equals success.

1.6. PREFACE: DEFINING SUCCESSFUL COMMERCIALISATION

The tender specifications as well as the discussions with the representatives of the European Commission during the inception stage of the study provided a conceptual framework of the range of matters to be analysed, ranging from successful knowledge transfer to successful commercialisation (market penetration). However, the emphasis was placed on the latter. The case studies of different projects and pathways of commercial exploitation of research results originating from these projects have been selected based on:

- whatever information the research team had on such activities (including activities that indicate at least the intention to commercialise such as patenting), and
- the responses of the individuals and organisations to an inquiry on exploitation and their respective involvement.

Therefore, all projects and consequently, case studies were selected for investigation as success stories based on the information available. However, the interviews have indicated that the term *'success' cannot be understood as a well-defined concept of any kind*. Thus, the issue of what actually defines a success (apart from the agreed definition that the technology, product etc. developed has to be available to the market) needs to be discussed not only in the context of this study but also in the wider context of any (not only European) research and innovation policy. Technologies developed in R&D projects funded by the European Framework Programmes or as a direct consequence of the research conducted in such projects reach the market in a very broad variety of ways and forms.

It became evident that *there is a variety of factual success stories, i.e. there is number of innovative technologies that are either available to the market or are very close to the market but are pending* until either an investor or customer/purchaser makes a final investment. The global economic downturn that started in 2008 had a profound effect on the commercialisation of many of the case studies investigated. There is less money available for the investment or purchase of new technologies. Since innovative technologies almost always have additional consequences for the purchasing organisation in that they lead to a need in adapting other processes etc. to a new standard (e.g. because the new technology either radically reduces the time needed for certain parts of a production chain or provides a completely new approach to a whole sector) the initial costs and lifecycle costs of new technologies often have to be met by additional investments, which make them even less 'attractive' under the current economic climate.

Case studies whose commercialisation processes have been affected by this but are still perceived as successes by all organisations involved.

In addition to this, the interviews revealed that *'commercialisation' is almost always conceived as directly converting whatever has been developed during the research stage into a product available to the market. However, there are only a few cases where such a direct and almost linear relation between research and market success was actually found.* By equating success with this type of pathway it would exclude successful exploitation stories such as spin-off companies founded in order to further develop and finally marketing a technology in form of a product, service, the incorporation of the knowledge obtained in already existing production processes or the (ultimately successfully marketed) transformation of knowledge through follow-up research projects. The processes investigated seemed (regardless of the type of organisation) to be much broader than 'just' commercialisation. For example R&D results are often further developed internally after an EU project was completed, followed by tests for a variety of potential industrial applications, but have not been fully commercialised, yet. Still, the organisation continuously invests in these technologies and has no intention to write its investment off but waits until the respective regulations are implemented; the 'right' customer comes along etc. Knowledge spill-overs are apparent. However, it is in no way a direct commercialisation of R&D outcomes.

Exploitation of R&D outcome is a much-used term that basically describes the fact that someone does something with it, i.e. it covers everything from publications to commercialisation. Hence, exploitation widens the issues to be investigated in a rather extreme manner. For the sake of this study and its focus on understanding how and in which way results from EU-funded R&D projects reach the market, the research team decided to use the term market-oriented exploitation instead of either commercialisation or exploitation. *Against the backdrop of the fieldwork conducted, market-oriented exploitation can be defined as: any exploitation process of research outcome that has a commercial objective, i.e. it ultimately (aims for or) contributes to gaining or increasing profits and/or economic (i.e. market-related) competitiveness. As a condition, there has to be a traceable link between the research outcome and the supposed economic effect.*

For the sake of focus the research team also decided to *limit successful market-oriented exploitation to those cases where – at one point or another – a conscious decision about the exploitation was made (and is traceable as well)*. In contrast to commercialisation, market-oriented exploitation is not at all limited to companies. In fact, commercialisation even in its narrowest definition is not limited to companies but for non-commercial organisations such as universities the term almost never applies due to the immediacy it implies.

Defining successful commercialisation

→ cannot be understood as a well-defined concept and there is a variety of factual success
→ commercialisation is a special type of commercially exploiting research outcome (directly converting whatever has been developed during the research stage into a product available to the market)
→ market-oriented exploitation can be defined as: any exploitation process of research outcome that has a commercial objective, i.e. it ultimately (aims for or) contributes to gaining or increasing profits and/or economic (i.e. market-related) competitiveness.

1.7. EXAMPLES OF PATHWAYS OF MARKET-ORIENTED EXPLOITATION

The following three fictitious examples of pathways leading from R&D projects funded by the European Framework Programmes to successful market-oriented exploitation represent three different types of stories that were identified during the fieldwork. They were designed by combining elements of similar real cases in order to highlight aspects of pathways of market-oriented exploitation that often occur together – even if their individual relevance and impact is different for each of the different real cases they are taken from.

1.7.1. EXAMPLE 1

For a (larger) minority of case studies investigated the narrative behind the pathway of market-oriented exploitation is rather linear and straight-forward.

Being a mechanical engineering company that produces mid- to large-scale machinery for a specific type of processing high-cost construction materials, the company is used to responding to customers' fast changing needs, e.g. towards the characteristics, performance, energy consumption etc. of their machinery. Thus, small-scale innovation is part of the company's daily business based on market knowledge and customer feedback. More research-intensive development projects are far less frequent but nothing new. In either case, the technology development is driven by performance criteria rather than the search for radically new and different approaches to any given industrial need. The company has been present for more than 50 years, has a well-established set of customers and markets it is serving and, consequently, only a limited number of competitors. The company's staff is well-experienced in handling new knowledge through either formal IPR or other types of protective measures. Although the company is primarily dealing with customisation, its customers value the fact that its basic technologies are patented, which in turn increases the 'value' of their production processes and the price of their products. Patents granted are perceived by their customers as certificates of quality.

The decision to engage in the R&D project in question was triggered by an emerging niche market, i.e. the economic niche or (potential) demand triggered thinking about an innovation. A collaborative approach was selected because the company already controlled the core technology (and already held a corresponding patent) but needed additional expertise. Furthermore, the innovative solution targeted required corresponding solutions not developed and produced within the company itself. Thus, the involvement of the full value chain was seen as unavoidable. Being without serious competition in their main markets, involving the whole value chain was not only comparably easy but also built upon previous experience regarding cooperation with most of the other companies and research organisations relevant. Those project partners that were new to the company had extensive ties to one or more well-known partners. Naturally, the different organisations within this value chain produced some overlap in competences, ensuring a further minimisation of technological risks.

Apart from reducing the – already rather small and controllable – technological risk, another issue in the conceptualisation stage was the minimisation of financial costs, which consequently lead to the search for available public funding. The European Framework Programme was chosen for two reasons: national public funding was not available, and the cooperation partners originate from different European countries. Thus they would not have qualified for national funding anyway.

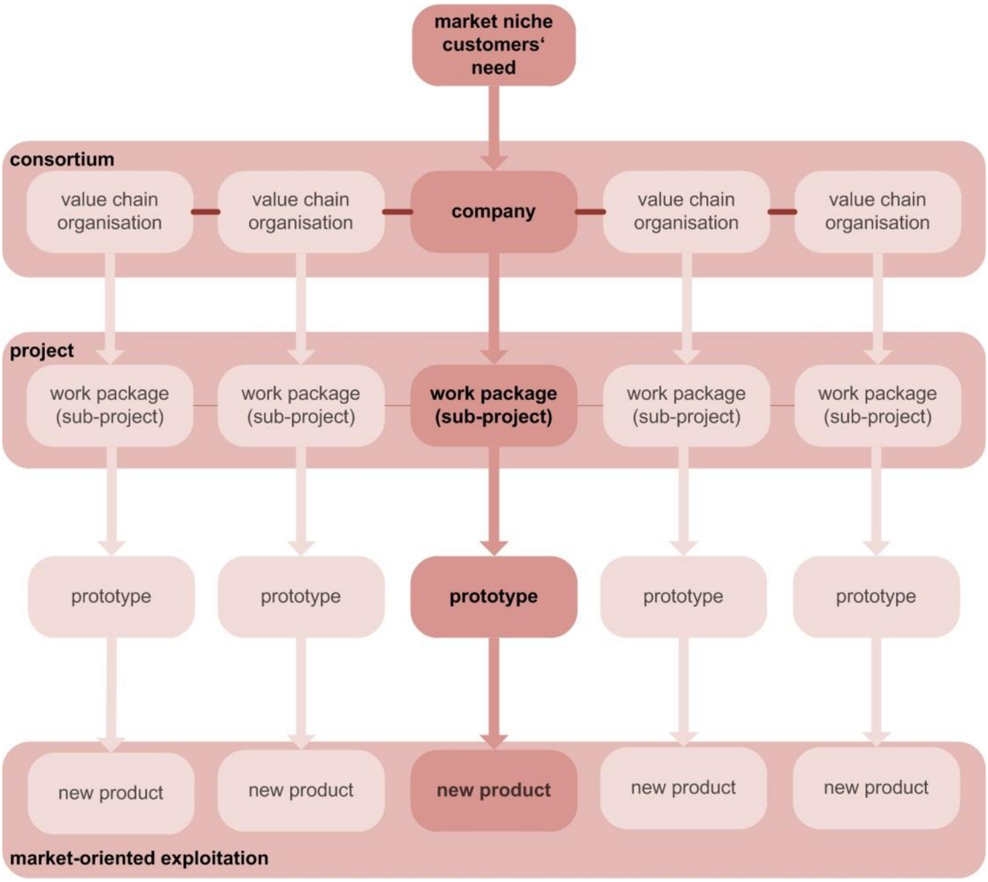
As the project was industry-driven and aiming for an innovative solution within controllable technological boundaries, it was clear from the beginning that the research would be targeting the development of a prototype and a proof of the feasibility of the underlying technology. The proposal was granted funding without major changes.

The project's design followed the well-defined niche market's requirements and was based on the rational of the whole value chain being involved by establishing work packages – or sub-projects - dealing with different elements of the technology assigned to different partners. Thus, every organisation representing a part of the value chain retained control over its respective domain of expertise (and economic interest). Nevertheless, communication of knowledge and issues crossing these sub-projects was regular and intense. Customers were not involved but since the project was built upon their need, it was not considered an asset. Other projects that took a similar pathway involved customers to ensure the alignment of research to the (potentially changing) needs by allowing the customers to influence the process. For some projects the industrial need it was based on was not as well-defined and thus, the customers were involved to jointly develop the exact issue and potential solutions to it.

By keeping the research within the boundaries of a basic technology already well-established and controllable, the research process itself went smoothly without any setbacks or modifications. The research outcome met both the expectations and the requirements of customers. All the while market knowledge was the very basis for the whole innovation process, the consortium collaborated with an external expert who provided further insights into markets, market changes and potential applications beyond the one the innovation was designed for. Being solely responsible for its own sub-project within the overall innovation process, the company thereby also ensured input from an outside source to prevent a lock-in effect.

The prototype was successfully built and tested, and met all the requirements of the customers and the niche market, respectively. Within a very short time period, the company was able to produce machinery based on that prototype and successfully occupying the niche market targeted. However, the global economic crisis partially limited the economic success due to the failure of some of the company's main markets.

FIGURE 4 PATHWAYS OF MARKET-ORIENTED EXPLOITATION, EXAMPLE 1 FLOWCHART



Source: Austrian Institute for SME Research 2012

Figure 4 exhibits a simplified flow chart of the exemplary pathway of market-oriented exploitation described above. What is striking about the stories behind it – and thus, has been emphasised in the figure – is the *decrease in cross-links between the different parts of the research conducted that actually disappeared by the time the research advanced to its innovation stage. From the very beginning, the consortium was not cooperating in the sense of a joint innovation being targeted. Knowledge transfer occurred but as a side-effect*. Apparently, conducting research rather side-by-side than collectively is not an obstacle to successful market-oriented exploitation. On the contrary, it reduces as number of cooperation-related costs and allows participants to protect their individual spheres of interest much more easily and effectively. While this type of behaviour might diminish the scope and impact of an innovation developed – because what is exploited are individual project partners' 'parts' of the technology – it seems to make the market penetration easier (manageable).

1.7.2. Example 2

The lion´s share of cases – deriving from R&D projects funded in the Framework Programmes and investigated by the research team – follow a *rather non-linear exploitation pathway towards the market that for several reasons involve significant additional efforts and costs.* The following description gives two examples

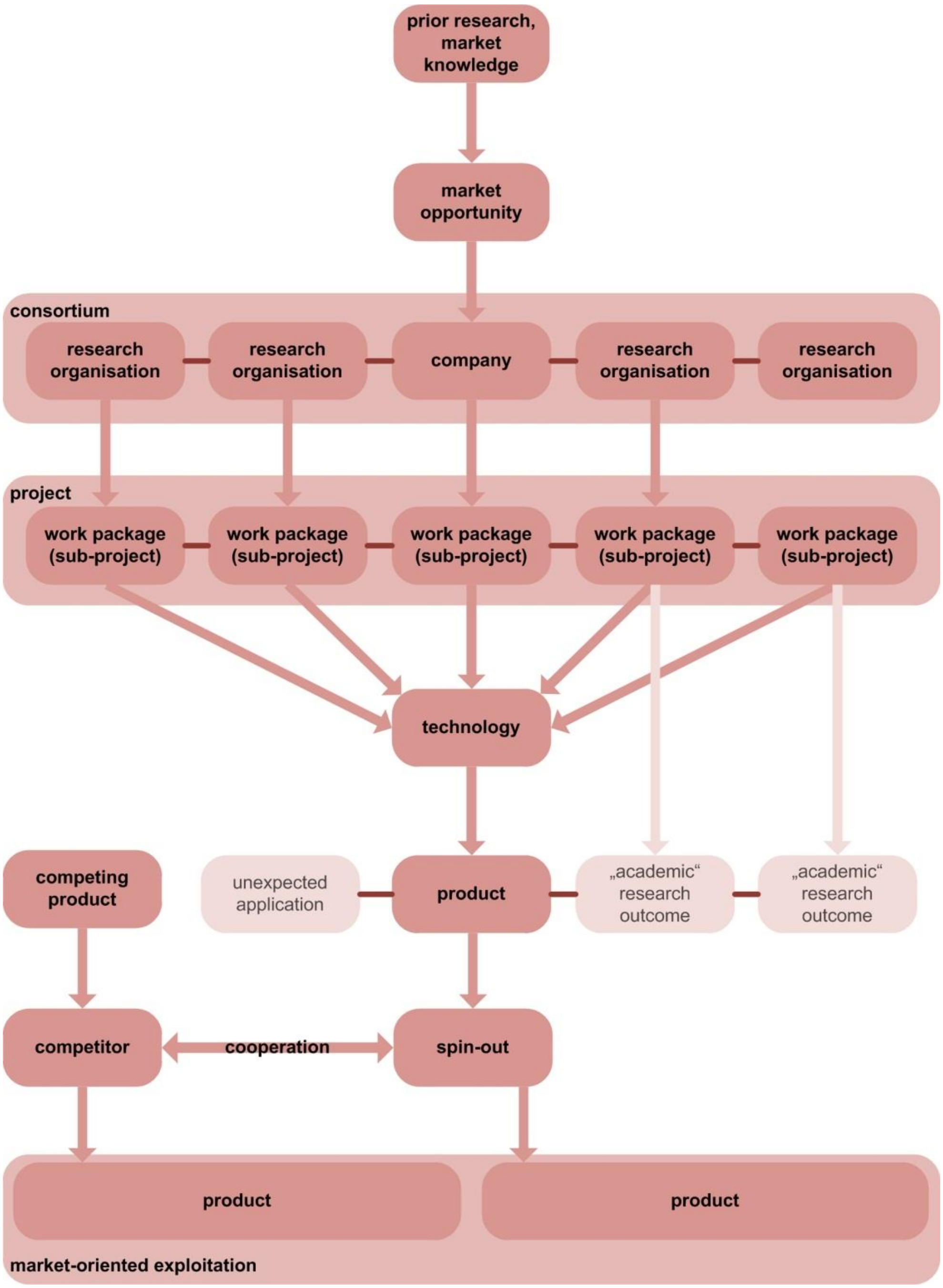
A large company had a patented technology and identified the need for further development, testing and demonstration of this technology. The company was the main driver within the project but also of the technology itself. It had a well-defined idea and research agenda in terms of developing the technology towards an industrial application and thus, took the coordinator's role of the project. In addition, the company knew their potential competitors very well from the beginning of the project and continuously monitored their activities during the research and innovation stage. Hence, another goal was to develop a better technical solution and gain a competitive advantage. Consequently, it built the consortium by avoiding any technological or economic competition: next to the coordinating company most of the other organisations involved were research organisations and higher education institutes. Their tasks and knowledge was complementary to the company's and the project was designed to allow them to follow their own research interests within the project.

The company was basically following their predefined goals, the research went smoothly and without facing major challenges. Nevertheless, during the project an unexpected application opportunity emerged, which also seemed economically promising for the company and some of the partners. As a result of a market screening it turned out that a comparable yet inferior technology was already available. Thus, the company (and the project partners) abandoned it. In addition to a competitive technology being already marketed, the application field would have been outside the company's expertise and no other partner would have been able to complete the development.

Although the project – in its original concept and orientation – successfully produced the technology targeted, the company was not able to bring the technology directly to the market. *The technology did not fit into the company´s organisational structures with regard to the distribution channels and the necessary specialisation. The logical decision to create a spin-out company – that turned out to be the main step towards success – was made at the very end of the project. In other words, without this additional non-research related activity the market-oriented exploitation of an otherwise successful R&D project could not have happened.* Additionally, the company also agreed to cooperate with one of its potential competitors, thus further ensuring economic success. The spin-out delivers the product based on its superior technology and the competitor integrates the product into their own line of production and acts as a supplier due to its larger customer base. *The additional activities were co-financed by a national funding programme for the establishment of spin-outs (out of internationally oriented companies with a strong focus on R&D activities), which was crucial for entering the market with the developed technology.*

In other cases similar additional activities (i.e. integrating a new business area in the existing portfolio by altering the organisational structure) have been used to create a sound 'environment' to transform the research outcomes towards the market. However, most of them did not receive public co-financing as only few support measures exist for these stages of (organisational) development. *For most organisations the follow-up activities that were decisive for a successful market-oriented exploitation were research-related.* Usually, projects produced an outcome closer to research than innovation. In order to benefit economically, organisations decided to finalise the development of an outcome and/or add a further testing phase. The latter is sometimes mandatory, e.g. in most medical applications. Very often, those additional research activities (mainly with a focus on additional R&D rather than further developing a prototype or something similar) were supported by national or European funding programmes. Others cooperated with partners from outside or within the original consortium to integrate research outcome with developed applications to complete the innovation process.

FIGURE 5 PATHWAYS OF MARKET-ORIENTED EXPLOITATION, EXAMPLE 2 FLOWCHART



Source: Austrian Institute for SME Research 2012

As an example of those case studies wherein additional activities created success in market-oriented exploitation, Figure 5 illustrates two main success factors: Although the majority of success factors are to be found within the market investigation and the following R&D project, the most decisive ones are part of subsequent activities. *While additional research-related activities are more common and necessary, the willingness* *and ability to undergo organisational change (e.g. by establishing spin-offs/-outs or re-organising existing structures and modes of operation) are crucial whenever a technology (product, service etc.) is not fully within the organisation's field of core expertise.*

1.7.3. Example 3

As discussed above, the question of success in market-oriented exploitation cannot be easily answered. *A small group of case studies did not produce research outcome that in itself was subject to market-oriented exploitation processes but – for different reasons – produced spill-overs indirectly responsible for economic success.*

The *project idea was developed by a public (applied) research institute based on an identified technological opportunity resulted from previous research*, i.e. a theoretical proof of concept, rather than a narrow and well-defined customer's need or niche market. Since this institute permanently and intensively cooperates with private companies, they brought together a group of potentially interested people, which also represented the value chain. All companies involved are suppliers of either products (e.g., machinery) or services (e.g., planning or scaling-up) to each other, and ultimately, to the chemical industry. Thus, they are – apart from rather non-frequent involvement in research-intensive innovation processes – constantly dealing with innovation processes targeting customisation and performance needs. *The basic technologies were well-known to all partners and the cooperation was basically meant to join different angles and perspectives to the general technological approach* and the area of (potential) application of the innovation targeted. One of the companies also added two (potential) customers to the consortium, which was only natural since the project – despite it not being a reaction to a well-defined industry need – was aiming for an industrial application through market-oriented exploitation right from the start. All companies involved enjoy a market position more or less unchallenged by competition. Thus, it was possible to involve the whole value chain without involving competitors.

Due to the nature of their daily innovation business, engaging in a publicly funded R&D project was not the norm but an exception for most of the organisations involved except, of course, for the research organisations. Prior to the innovation process in question, the research institute that developed and later managed the R&D project cooperated with all of the organisations involved but the latter did not cooperate with each other. The decision to submit a proposal for funding to the European Framework Programme was made by the research institute based on the involvement of international partners, which would not have been funded within any given national funding programme. A collaborative approach was chosen simply for feasibility reasons (i.e. the consortium had to have every bit of expertise along the value chain) and only to some extent to minimise risks by sharing costs and resources.

As the R&D project was simultaneously driven by research and targeting market-oriented exploitation it was designed and managed in order to deliver a demonstration project that – with the support of the customers involved – would have been developed into a prototype. *The involvement of customers was seen as an asset to safeguard the sustained alignment of research to industry needs.* The proposal was granted funding without major changes.

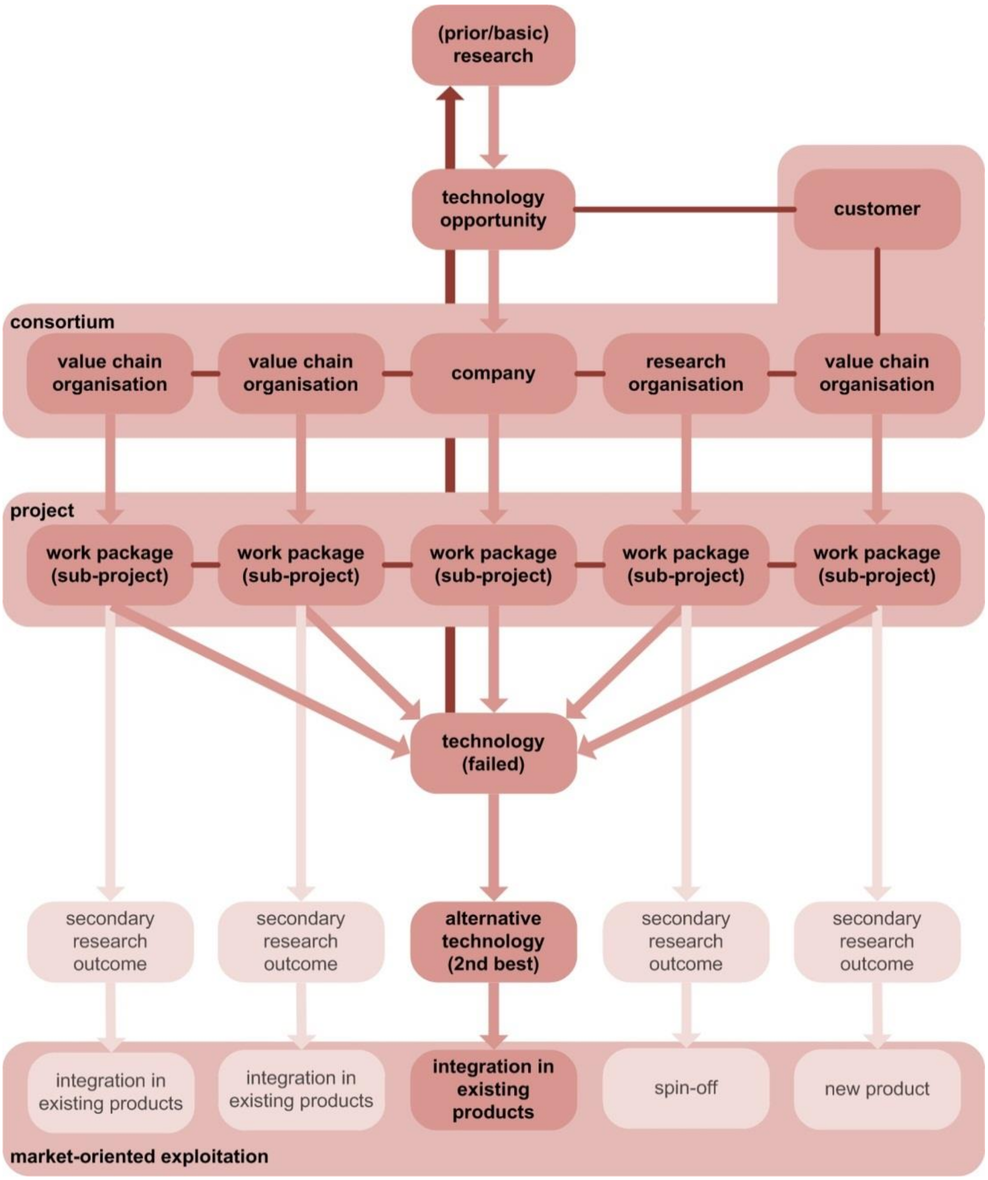
While the project was organised along different work packages tailored to the different elements (represented by different organisations) of the innovation process and the value chain, respectively, it was aiming for the development of a joint innovative solution. Thus, every work package had to deliver results that later would have to be combined into a system containing every organisations' contribution. Aiming at the development of a demonstration project for large-scale applications, the research, modelling etc. were conducted successfully but the *manufacturing of one single construction component needed for the demonstration facility turned out to be impossible without compromising the performance and quality characteristics of the actual system*. Consequently, the whole R&D project came to a temporary halt. The consortium decided to continue with a 2nd-best solution that was at least close to the one originally aimed for and the EC approved of the respective changes of the research project.

In sum, the project goals were not met as the research conducted revealed that the technology does not work as foreseen, at least not on a larger scale (while it does in small-scale facilities and in the laboratory). The unsolved technological problem recommitted the research to more theoretical and basic research. *While the companies will very likely pick up the technology once the basic research has produced a solution, they do not continue their own research in that area, neither on their own nor in cooperation.* With a final result like this, the research and exploitation collaboration came to an end for the most part. Instead of jointly commercialising an innovative solution developed in cooperation as planned, every participating organisation took whatever secondary research outcome 'their' work packages produced to the next level.

One of the companies involved, together with one of the participating customers, tried to convince another customer (who was not part of the consortium) to finance the construction of a facility based on their *2nd-best technological solution*, which nevertheless seemed economically promising but the customer declined. Still, the company is confident that in the near future this solution – as long as no competitor or the company itself manages to fully develop the original approach or something comparable – will be in demand. However, even the alternative, 2nd-best technology is being used in their products and services and had a positive economic effect. One of the research organisations involved successfully incorporated their research outcome into a different technology and managed to found a spin-off.

In other cases, the failure of the technology researched did not seem to be an issue at all and did not 'reduce' the opportunities for market-oriented exploitation to secondary research outcomes or other knowledge spill-overs in form of 2nd-best solutions or additions to other existing (parallel) innovation processes but were exploited by investigating the possibilities to develop and apply an alternative technology. *Often, the decision to go for the alternative technology due to the technological failure of the original research seemed to be a less-than-ideal solution. However, such behaviour was – primarily linked to large companies being involved in publicly funded R&D projects – also found to be strategic in other cases.* Using public co-financing for what is referred to as technology scanning occurs regularly. Companies are sometimes utilising cooperative R&D projects as testing environments for one of two (or more) technology alternatives from the outset; if the project fails, the alternative technology is likely to work and will be commercially exploited.

FIGURE 6 **PATHWAYS OF MARKET-ORIENTED EXPLOITATION, EXAMPLE 3 FLOWCHART**



Source: Austrian Institute for SME Research 2012

Knowledge spill-overs were considered examples of successful market-oriented exploitation by the research team (see chapter 4.1). Figure 6 shows a simplified example of a respective storyline or pathway. There are two main issues worthy of emphasis: (1) being rooted in results of prior research that opened a technology opportunity rather than 'simply' following a well-defined industry need the project faced a *comparably high risk of technological failure*, and (2) the close cooperation maintained throughout much of the pathway – in order to develop an integrated innovation – only dispersed when that integrated innovation was no longer available*. It also shows that economic success – based on research – does often take an unexpected path, and that sometimes a secondary research outcome becomes the core of a new and successful product or service.* Furthermore, the ability and flexibility to turn a 'failure' around by learning from it, re-thinking application opportunities, finding a 2^{nd}-best solution, or integrating the knowledge into other innovation projects (or already existing products or services) else is crucial.

1.8. Types of pathways of market-oriented exploitation

As this study's objective was to achieve a level of knowledge that allows modifying and improving the European Commission's support initiatives the research team had to transform the information obtained through case studies to a more aggregated level. To this end, the case studies' stories investigated have been analysed in order to identify patterns and to develop a categorisation of such patterns into types of pathways shaping these pathways. The categorisations build upon the case studies and have been refined against the backdrop of the discussions of the internal workshop, the research team held together with its expert group and the input given by the European Commission. The following chapter describes and discusses this categorisation and illustrates it with examples.

1.8.1. Converting or transforming knowledge? Basic types of market-oriented exploitation

Chapter 4.1 has shown why the term market-oriented exploitation replaced the term commercialisation. At this point the latter will be 'recycled' for a specific type of pathway. Among the different success stories the research team has analysed a comparably small group emerged that (contrary to the complexity etc. discussed above) managed to convert their research in a very direct, linear way into a product or service available to the market without including major additional development steps. As the interviews have shown the term commercialisation is often understood as applicable only to this very direct, linear type of research exploitation aiming at the market and economic effects. *Hence, the research team decided to label this first type of pathways from research to the market as commercialisation where additional activities were often involved but were not substantial. The respective findings were primarily linked to smaller R&D projects with a rather narrow technological focus that are usually industry-driven and were often designed to address a pre-defined industrial need / demand.* As one would expect, there are of course subtypes of this pathway, which will be addressed later.

The second type of the classification of market-oriented exploitation pathways summarises every type of pathway that the research team found to be non-linear (i.e. substantial additions, modifications etc. were observed). This type forms the lion's share of the case studies analysed and largely dominates the overall picture. Thus, characteristics as non-linearity, complexity or the notion of pathways of market-oriented exploitation as being full of set-backs, feedback loops etc. are by far most frequent in the findings. Within this type, the non-direct market-oriented exploitation group, there is a large diversity of pathways to be found. In the following, these will be described and labelled accordingly.

FIGURE 7 MAIN TYPES OF MARKET-ORIENTED EXPLOITATION

Main characteristics	Label / category
Linear and "prompt" *conversion* of research outcome into a product or service available to the market	commercial conversion (commercialisation)
Non-linear and "deferred" *transformation* of research outcome into a product or service available to the market	commercial transformation

Source: Austrian Institute for SME Research 2012

Pathways of market-oriented exploitation labelled as commercial conversion or commercialisation are defined by the almost fully linear relation between the research outcome produced in an EU-funded R&D project and a technology, product or service available to the market. The research team has chosen the term 'available to the market' because a) this study is not investigating commercial success in terms of significant profits gained through market activities (market penetration), and b) a number of technologies etc. especially developed in FP6 hit the market with a rather unfortunate timing, i.e. they were made available in the midst of the global crisis of the financial markets. Therefore, the linear market-oriented exploitation processes (aka commercialisation) have to be divided in pathways leading to a full commercialisation and pathways that – currently – have to be seen as pending or (still) potential commercialisation. The reasons for the pending status of linear commercial conversions of research outcome will be discussed in chapter 4.4 and especially chapter 4.4.8.

Converting or transforming knowledge?

→ conversion of knowledge (or commercialisation): direct and almost fully linear relation between the research outcome produced in an EU-funded R&D project and a technology, product or service available to the market

→ transformation of knowledge: non-linear, complex relation between the research outcome produced in an EU-funded R&D project and a technology, product or service available to the market

1.8.2. Transforming knowledge: types and sub-types of market-oriented exploitation

It has been stated before that there were almost no R&D projects in the sample analysed that aimed at market-oriented exploitation but did not generate even the slightest evidence of success in this regard. However, *the case studies revealed that the non-linear transformation of research outcome in processes of market-oriented exploitation take two distinct forms. The results of the EU-funded R&D project and its outcome are often at the centre of such processes, i.e. research outcome produced in other projects* *or non-research activities are added to these results. In other cases the projects' outcome is merged into other research.* Thus, commercial transformation type pathways contain two main subtypes: direct and indirect market-oriented exploitation processes. These two are separated by the significance of the research outcome (of the project funded under the initiatives in question) for the market-oriented exploitation, i.e. the question if it is still the centre of the processes analysed (however strong the modifications etc. based on additional activities might have been) or if it has been absorbed by another process.

The European Framework Programme aims – among other things – for two main strategic objectives (cited from 'The Sixth Framework Programme in brief'):

> *Based on the Treaty establishing the European Union, the Framework Programme has to serve two main strategic objectives: Strengthening the scientific and technological bases of industry and encourage its international competitiveness while promoting research activities in support of other EU policies.*

By primarily addressing the knowledge (science and technology) base of the European competitiveness through funding research the Framework Programmes do not necessarily focus on the commercial success of this research.

Although commercial success is well within the attention and objectives of the European Commission many R&D projects produce knowledge not ready for market-oriented exploitation, yet. Thus, it cannot be surprising that *a number of R&D projects investigated were followed by more research (to enhance a technology, develop it further, close the 'gap' to innovation and market needs etc.), often conducted in publicly funded R&D projects or in-house research projects. Despite the existence of many hybrid forms of market-oriented exploitation pathways, the analyses provided evidence that it is a (sub-) type in its own right. Hence, the first sub-type would have to be: market-oriented exploitation processes that rely on additional, (usually follow-up) research activities.* This additional research sometimes refers to new research conducted in larger consortia (e.g. in the following Framework Programme) or activities rather aiming for refinement, modification, advancement of the research outcome into a marketable technology (and ultimately product or service), which are often conducted in-house. *According pathways are usually linked to more research-driven projects and projects closer to basic than applied research but in fact also apply to industry-driven applied research projects whenever the technology developed does not work as intended or proves to be not feasible, yet.*

A second sub-type of non-direct market-oriented exploitation processes comprises cases that were successful due to additional, follow-up activities not related to research. The case studies investigated produced evidence that for some organisations involved – whatever the research outcome was – the *key to market-related success lies in building new organisational structures within which the research outcome would be commercially exploited (e.g. spin-offs, spin-outs, start-ups or research centres) or in re-organising existing structures and modes of operation (e.g. by establishing a new department, business area or changing / expanding existing ones). A second group is linked to the development of adequate business models, marketing / sales strategies etc.* Both sub-types are often linked to projects not driven by a pre-defined market demand (but still focussed on applied research). Thus, they often develop a technology that in principle is rather easily transformed into a marketable solution but the organisations involved do not have the right set of tools to actually market it. For some organisations the technology is somewhat outside their technological 'core' (i.e. the research outcome does not complement whatever the organisation usually develops and markets) or even outside their organisational mode of operation (i.e. a non-commercial organisation such as a university engaging in commercial activities). Hence, outsourcing the market-oriented exploitation of the research outcome into a marketable solution (including activities of transforming) to a newly established organisation or part of the mother organisation becomes necessary. Market-oriented exploitation by licensing out to another organisation could – in a very broad understanding – be included here although the research team did not find evidence of licensing out apart from respective consortium agreements.

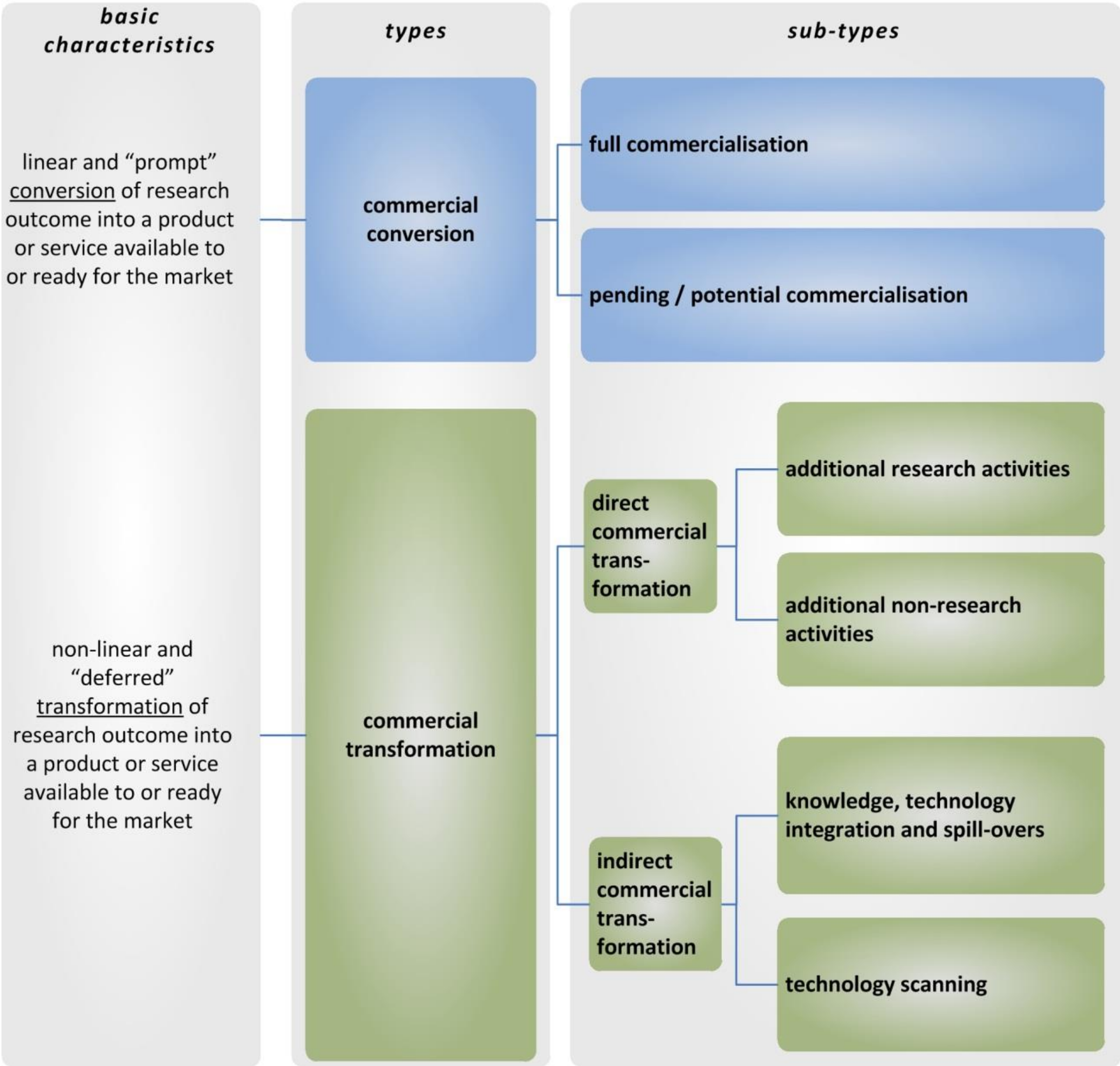
It has been discussed above that success in market-oriented exploitation processes takes various forms and follows very diverse pathways. Some of the case studies investigated have to be included in a second nonlinear subtype: indirect commercial transformation. Despite the fact that the required criteria traceability and conscious decision-making are met, the impact of the research outcome produced during the EU-funded R&D project on the actual exploitation seems to blur. In contrast to direct transformation of research outcome being transformed – where additional research outcome or additional non-research activities were integrated into or added to a technology, product or service 'dominated' by the NMP-related technology or research outcome –*nonlinear transformation combines market-oriented exploitation processes of a more indirect quality, i.e. the research outcome is either integrated or produced findings that add to another R&D project. It primarily comprises pathways for which the aforementioned outcome is merged into other technologies or research outcomes and the respective market-oriented exploitation processes.* These processes can be described by applying terms such as knowledge integration or (knowledge, technology or market) spill-overs. Examples of such pathways primarily refer to cases where the R&D project's outcome does not constitute anything that is relevant for market-oriented exploitation in itself but may contribute to the solution of a (e.g. technological) problem encountered in another research project or production process already established. Indirect market-oriented exploitation also refers to a distinct behaviour of primarily larger companies when participating in R&D projects called technology scanning or mapping. Two types of technology scanning were observed in the case studies analysed:

- A research project analyses the possibilities of one of two (or more) technological alternatives. While the technology itself is found not to be feasible it proves that its alternatives work.
- A research outcome is not exploited commercially because an alternative technology already exists and is being marketed. The organisation decides to use the alternative as a basis for further development.

In order to distinguish knowledge integration / spill-overs from technology scanning indirect commercial transformation of research outcome can be broken down into two different sub-types.

Before entering into the discussion of hybrid forms of these types of market-oriented exploitation pathways the following Figure 8 gives an overview of the full categorisation.

FIGURE 8 **CATEGORISATION OF MARKET-ORIENTED EXPLOITATION PROCESSES**



Source: Austrian Institute of SME Research 2012

Any form of categorisation cannot ignore the fact that even comparable market-oriented exploitation processes can take very different roads in the later stages of these processes. Thus, deviations from and hybrid forms of the pathway types discussed above should be the norm rather than the exception, which in fact they are. For example: Taking a look at the basic characteristic of research and innovation as a continuous process with various feedback loops, it becomes evident that they almost always build on other research or innovation processes conducted and lead to follow-up research and innovation processes. However, this study tried to identify pathways leading from one particular R&D project to its successful market-oriented exploitation, i.e. for the sake of focus and feasibility the research team had to break off the pathway in question from what otherwise would have to be treated as a continuum. Therefore, direct commercial transformation using additional research activities is limited to those pathways for which additional research is the direct link between the R&D project in question and the market. In reality, pathways of this type often resort to additional non-research activities such as building new structures for the market-oriented exploitation.

This is often the case if:

- the research (and its outcome) is very advanced or more advanced than 'usual' or the outcome is 'unexpected'. Organisations, even companies, are sometimes unable to integrate the new technology into their portfolio, existing exploitation strategies etc.
- the research outcome could be exploited commercially but the organisation is a non-commercial one. Market-oriented exploitation might not be at all a mode of operation and the respective tools and human resources might not exist within the organisation. Licensing out could be an option but so is founding a new organisation.

In many cases where the research team found evidence for a combination of additional research and non-research activities it is difficult to decide which one is dominant in terms of having the stronger impact on the successful market-oriented exploitation.

In addition, knowledge spill-overs exist for every case study investigated and might exist for many cases of no apparent success (what could be referred to as a third main type but was not investigated). However, the research team decided not to merge this type with the others. Some organisations involved in the R&D projects were not involved as a core member but provided different services to others that are of course linked to the research itself. However, these organisations sometimes gain knowledge that consequently can be exploited commercially, although they are only a by-product of the research conducted. For others, the aim of participating in the R&D project was to investigate one of two alternatives (see above) and the one at the focus of the project did not prove to be feasible. The knowledge spill-over created enables the organisation to concentrate on whatever is working but additional research activities might still be needed. Thus, one pathway might very well (and often does) pass into another.

1.9. IMPACT FACTORS

The following chapter describes and discusses different impact factors for successful market-oriented exploitation. It is important to bear in mind that these were identified through qualitative interviews; thus, there is no quantitative assessment or weighing of their effect available.

1.9.1. TYPE OF R&D AND INNOVATION

The type of research (i.e. basic vs. applied research and the various graduations in-between) is a major impact factor for successful market-oriented exploitation. Although there are a number of R&D projects that 'violate' the common rule that basic research scarcely produces commercially exploitable output directly, *the majority of success stories are linked to R&D projects of more applied research.* The latter have the advantage that market-oriented exploitation is an essential part already during the conceptualisation stage or in fact the trigger for developing a research project. However, rather basic research projects are fully capable to successfully produce more or less direct market-oriented exploitation by involving potential customers or end-users whose main task is refining the research outcome towards potential applications.

In any case and regardless of the R&D project being basic or applied, successful *market-oriented exploitation depends very much on who is driving the research within the project.* Even in applied research, an academic partner can drive a project and thus, dominate the type and scope of economically relevant outcome.

> ***Case 35:*** *A project focussing on rather basic research, involved potential end-users in an anticipatory way. Nevertheless during the whole project the research institutions involved were driving the research in the project even though several meetings with the potential end-users took place as planned. Towards the end of the project, while trying to break down the research together with the (potential) end-users, it turned out there were different approaches, views and needs regarding the results. ['…in the end it was hard to use it…']. The project team managed at a very late stage of the project to actually integrate the input of the end-users together with research because the research institutions were the drivers in the project and were intensely engaged in following their basic research interests most of the project period.*

The issue of applied vs. basic research in the context of industrial technologies is often *linked to the thematic split between nanotechnologies, materials and production processes (N/M/P) especially in FP4-6 (in FP7 nanotechnology itself was already much closer to applied research).* Most R&D projects can be assigned to one of the three but there are some that were focussed on topics in-between. These three main thematic categories of research are located at different positions on a continuum between the poles of basic research and applied research: nanotechnologies (as in the projects analysed) are closer to basic research while production processes are closer to applied research; materials research varies but would be located between the two.

Linked to the type of research and the thematic N/M/P split is the *type of R&D outcomes.* Such outcomes of basic research projects (e.g. in the area of nanotechnologies) are often platform technologies, which can be the basis for various products or services emerging without intermediary step of developing new technologies. Therefore, the variety of potential applications and the market-oriented exploitation is wider. *Successful market-oriented exploitation of platform technologies is linked to the ability to fully exploit the whole range of potential applications.* There are two main successful strategies to achieve a maximum range: (1) include a partner in the consortium who is able – due to organisation size, number of markets targeted or economic foci – to exploit all or most of the application potential, or (2) safeguarding external cooperation with a larger number of potential exploitation partners (thus, covering a maximum range of exploitation possibilities) via approaching them directly (and individually) or by creating publicity through dissemination activities.

Success in market-oriented exploitation of nanotechnological research output (nanomaterials and nanoparticles) is additionally affected by the exploiting organisations' ability to manage the public opinion since the issue of potential nanotoxicity is highly debated and object to a number of on-going studies and legislative procedures.

> ***Case 27:*** *A project in the area of nanotechnology focussing on nanosafety (at that time a rather new field of research without established paradigms or standard practises) was mainly dealing with research of highest scientific quality involving many academic research partners and emphasising the importance of creating a basis for understanding and potential predictions of likely impacts of certain*

materials. Further the result of the project was a standard characterisation step for determining nanoparticle impacts and the project is clearly linked to two follow-up projects/networks, funded by the European Commission.

At the beginning of the project and during the project there was a great uncertainty; different scientists were reporting different results. It was held at an overall meeting on the topic of nanotoxicology, where different regulators had deep concerns, and also the EU-parliament was discussing at this time a result from an EU-wide survey, that nearly 50% of the EU- population wanted a moratorium for nanotechnological applications in consumer products. As a consequence the project hung somewhat in the balance awhile because amongst other issues the public opinion was influencing the EC´s thoughts whether funding such a research topic is legitimate or not. Nevertheless, the EC services were supportive and in the end the project had some impact on the public perception at least as far as various regulation authorities are concerned who adopted practises from the developed standard. Also two sequent follow-up projects show the impact on the public opinion. Public opinion can influence research and the other way round.

In sum, R&D projects in the field of production processes are more successful with regard to market-oriented exploitation. However, it needs to be emphasised that this is due to the general level of applicability of the technologies and does not qualify as evidence of nanotechnologies or materials research not being exploited commercially. In fact, applied research is rather faster when it comes to market-oriented exploitation than simply more 'fit' and many of the projects funded under FP 4-6 that did not qualify as success stories yet, might be very well become successfully exploited in the (near) future. *Production technologies are often (not always) based on mostly known technological trajectories and therefore easier exploited commercially while nanotechnologies are more difficult to validate* and their market-oriented exploitation requires higher investments and often a combination of several R&D projects, research outcomes, innovations and non-research related activities such as developing new business models or implementing changes in organisational arrangements. However, their potential for more radical innovation and economic success is often much higher.

Another characteristic of the research conducted (or rather its outcome) affecting the success of market-oriented exploitation is the level of novelty (e.g. research breakthroughs or radical innovations). There is of course a link to the general level of applicability of research (outcome) (basic vs. applied research; see above) but basically any type of R&D project can produce a radical innovation. However, the impact on the success of market-oriented exploitation presents itself in two distinct forms: *a research breakthrough (or radical innovation) does either equip the organisations involved in its exploitation with vastly extended possibilities and opportunities* (scope of the exploitation, new application areas etc.) *or it sometimes blocks the chance of market-oriented exploitation (almost) completely.* The latter occurs whenever the level of novelty means that there is no market pull, the market is blocked by another (usually much more mature but well-proven) technology or the new technology cannot be integrated into existing production processes. Successful market-oriented exploitation of radically new technologies is especially dependent upon creating either a technology push (via standards or simply through market pull) or a market for the technology (via public procurement, innovative marketing, and innovative business models).

Research fields and level of innovation as impact factors

→ applied R&D projects are commercially exploited faster and more easily
→ for FP6 and earlier this means that nanotechnology < materials < production processes regarding speed and success rate of market-oriented exploitation
→ successful market-oriented exploitation of platform technologies is linked to the ability to fully exploit the whole range of potential applications
→ for some research fields, successful market-oriented exploitation heavily depends on managing the public opinion
→ a research breakthrough (or radical innovation) does either vastly extend commercial possibilities and opportunities (scope of the exploitation, new application areas etc.) or blocks the chance of market-oriented exploitation (almost) completely

1.9.2. Consortia and cooperation

The *involvement of industry in R&D consortia increases the success rate of market-oriented exploitation in general* based on their inherent orientation towards markets, which is not to say that an exceptionally high share of industrial partners also has an exceptionally positive impact. Some case studies suggest the contrary as the potential for conflicting interests and diverging directions can also increase accordingly unless the project management is able to avoid or dissolve such conflicts and problems. However, the impact of industry participation widely differs along various characteristics. Whenever companies were involved as customers it enabled the consortium to almost constantly check for its alignment to (potential) customers' needs. Usually, those customers become early adopters of the technology developed or engage in advancing research outcome into fully developed innovations if needed either in cooperation or by acquisition of the technology (sometimes including the personnel that developed it).

Furthermore, many commercially exploited research projects involved (potential) *end-users to safeguard the actual application of knowledge produced.* However, given a certain technological risk and thus, an uncertainty of the actual success (in terms of an 'applicable' outcome) and ultimately the definite area of application, *some cases suffered from the fact that the involvement of end-users can limit the scope of thinking when it comes to the market-oriented exploitation.* This negative effect is strongest for those projects where the end-users focussed on one rather narrow industrial sector. Therefore, the positive effect of involving end-users somewhat depends on the flexibility that is 'left' with regard to application areas, which ultimately depends on the R&D project and whether or not it is focussed on a narrower problem/application anyway. Some interviewees have pointed out that it would be *more favourable to involve end-users that are technology 'integrators' rather than 'just' manufacturers* to avoid such limitations. Larger project consortia (such as IP in FP6) with a wider research focus and a certain degree of diversity of industries seem to have benefited more from involving end-users and managed to limit the potential negative effects at the same time. The positive effect of involving customers and end-users is strongest whenever the core members of the consortium are not (or cannot be) fully certain about the potential markets. Projects where there were one or more end-users involved that were not implementers of the technology (manufacturer or producer) tend to result in comparably weak market-oriented exploitation since even if there is a customer to use it, there is no one to actually manufacture the product.

Involving all relevant elements of the value chain is also a success factor for market-oriented exploitation of research outcome. It helps safeguarding the inclusion of all aspects that are relevant especially for the exploitation stages and the possibility of developing large-scale innovative systems instead of fragmented small-scale solutions.

Whenever *large companies* are involved they certainly *have a huge impact on the* success of market-oriented exploitation by effectively and constantly shaping the processes according to their needs. *As long as the research outcome and the respective market-oriented exploitation processes are in line with their expectations their (combined) market power tend to make a difference.* However, such partners seem to be much more difficult to coordinate and do usually enforce their points of view for better or worse.

As with every other aspect of the composition of the R&D consortium, the involvement of a SME certainly has an impact on the success of market-oriented exploitation, but this effect can be both positive and negative. *SMEs are faster and more flexible when it comes to innovation and commercially exploiting research outcome but often lack the necessary resources.* Thus, they are most important whenever timing (i.e. speed) is important to gain the maximum economic effect possible (i.e. arriving at the market before a competing organisation or technology does). In addition, they are able and willing to find and utilise market niches creating commercial opportunities missed by those that are unable or unwilling to do so. However, their intrinsic limit of resources (or lack, especially in comparison to large enterprises) can become a serious risk or obstacle. SMEs' are easier bought/sold; they get into economic trouble more easily and often cannot acquire additional personnel as easily as larger organisations. Whenever a SME has a crucial function within a consortium (e.g. industrial scale-up), the R&D project and the market-oriented exploitation can either benefit from this circumstance or become severely endangered.

The inclusion of (potential) competitors is an important impact factor and at the same time a potential source for challenges as long as the overall project coordination does not manage to separate them and their spheres of interest (or, in fact, manages to create a joint sphere of interest). Competing organisations were identified as having contributed to maximising the economic success of a technology in some cases as long as the agreements and project management facilitated a balance. This additionally depends on the type of research conducted and technology aimed for as it appears to be much easier for competitors to arrive at a common interest when platform technologies are being developed that (potentially) allow different applications that could be commercially exploited separated and independently.

> ***Case 25:*** *A professional project management organisation (which had no self-interest in the research outcomes but a professional and technical background in the research field) was able to include three large competing enterprises of the same economic sector. When they formed the consortium the immediate challenge was to include these companies (among other partners) – which would help to secure or more precisely solely resume the market-oriented exploitation and industrial application of the outcome – while they are competitors. Thus, the definition and delineation of separate work packages were crucial. Apart from the*

organising the project structure in disjunct work packages the project management also had to develop the respective agreements regarding existing and expected IPR, which was a difficult undertaking and required both in-house and external expertise. The large companies started commercialising (i.e. developing and testing industrial applications) already during the research by extracting certain (interim) results of the project and shifting their development inside the company including actively hiring employees of partners from the consortium. At the same time, the large companies used their resources to conduct additional research and testing and fed the results back into to actual project. It was only by giving these companies such an amount of leeway, their commitment, active cooperation and positive influence could be sustained. Ultimately, the result of the project was platform technology that provided three different applications that were divided among the large enterprises to exploit them commercially.

Conflicting interests tend to affect research and market-oriented exploitation processes even if the structure of the research project (i.e. sub-projects with a minimum of overlap) accounts for separation of competitors. However, such competition-based conflicts are not exclusively linked to economic competition. Especially the issue of conflicting interest in handling IP jointly developed can lead to situations where research organisations and companies sometimes enter a competitive situation (e.g. universities become more and more interested in owning IPR instead of focussing on publications as their standard exploitation result and are also required by national and internal policies to increase generation of IPR) although there should not be competition unless the research organisations want to commercially exploit the technology through a spin-out that would compete with the company. Thus, a successful market-oriented exploitation depends on the agreements developed and a project management being able to implement these without producing disadvantage for one of the partners.

Whatever the constellations of partners within any given research or commercialisation consortium look like, the success largely depends on the level of activity of the partners. Free-riding is a major obstacle to (research and market-oriented exploitation) success.

Although for different causes, the drop-out of partners is usually endangering successful research and consequently its market-oriented exploitation. Although the size (in terms of number of participants) is an often criticised characteristic of EU-funded R&D projects – i.e. they are said to be too large to be coordinated and conducted successfully and 'satisfactory' – there is evidence that a rather small project consortium can turn into a threat for market-oriented exploitation. *The drop-out of partners (usually linked to bankruptcy) in a consortium where each partner fulfils a certain function exclusively means that this consortium loses more than 'just' a member but a 'piece of the puzzle' that needs to be complete to be successful.* Thus, larger projects with larger consortia tend to be affected less strongly because substitution from inside the consortium is simpler (or actually possible).

Cooperation as an impact factor

→ involvement of industry in R&D consortia increases the success rate of market-oriented exploitation
→ end-users often safeguard the important application orientation of a R&D project but can limit the impact of market-oriented exploitation by limiting the application scope
→ vertical integration (i.e. including the whole value chain) in R&D projects is a success factor for market-oriented exploitation
→ large enterprises can make a difference in successful market-oriented exploitation as long as the research outcomes are in line with their 'expectations'
→ larger R&D projects with larger consortia are less strongly affected from mal-performance or drop-out of partners because substitution from inside the consortium is simpler
→ whatever the constellation of partners within any given research or commercialisation consortium is, the success depends on the level of activity of these partners and not their mere involvement

1.9.3. Management and governance of R&D projects

The importance of the project coordinator as an individual including his/her experience, technological knowledge, management expertise, personality has been emphasized by interviewees as a crucial element of success (for both research and market-oriented exploitation). The coordinator is most effective in larger projects or networks simply due to the larger amount of coordination and cooperation. However, smaller projects also benefit from an active, experienced coordinator. His/her main function is not only acting as a contact between partners (e.g. when they are not cooperating but work rather independently in separated sub-projects), acting as a person of authority towards individuals (e.g. researchers) working on sub-tasks without being fully involved in the whole project process or between the consortium and the European Commission but acting as an information broker within the consortium. If (potential) competitors and/or large companies are involved his/her importance increases. Naturally, the *project coordinator can only be as effective as the resources of his/her organisation allow him/her to be.*

Successful market-oriented exploitation processes are often linked to consortium agreements that entitle the project coordinator – as an individual or by making him/her head of a respective group or committee – to approve of every attempt of exploitation (commercial and non-commercial; from publications to patents) whether or not the coordinator is affiliated with one of the organisations involved in the research. Such agreements are most useful and effective whenever there are conflicting interests emerging.

Even though participants of EU funded research projects often criticise administrative burdens etc. their assessment of *the impact of the project/scientific officer – who have to be involved in many internal processes such as the modification of the research project – supervising the project turns out to be very positive in many cases.* A number of projects, sub-projects and consequently market-oriented exploitation processes have immensely benefited from *input given by project/scientific officers on available follow-up support, technological opportunities, market opportunities, interesting research results of other research groups, potential dissemination activities etc.* They have also repeatedly contributed to successful market-oriented exploitation by constructively criticising and discussing changes in research and exploitation plans necessary due to technological failure, pointing out potential cooperation partners for research commercialisation (not only whenever cooperation partners drop out of projects) and in general demonstrating flexibility whenever changes and modifications were necessary or favoured by the consortia.

> ***Case 14:*** *A consortium developed an innovative technology but by the end of their joint R&D project all partners that were responsible for triggering the demand by installing demonstrators and develop marketing strategies had dropped out (one literally burned down and the company it got replaced by went bankrupt). Although their project was successful in proofing the concept (technology) they had no access to the market. At this point, the project management was actively referred to the possibility to submit a proposal for a follow-up project that would allow them not only to build their demonstrators with financial support but also to develop an innovative business model. This reference was made by their project officer and – since they successfully submitted a proposal – was the basis for their market-oriented exploitation processes that otherwise would not have been possible.*

As R&D projects and the subsequent market-oriented exploitation processes are characterised by various uncertainties, the *ability of organisations and consortia to manage respective risks – and in the event of a risk becoming an actual challenge or threat: emergencies – is crucial for success.* Usual, threats and challenges become real due to technological failure or the drop-out of a consortium or cooperation partner. Although a majority of success stories do not have to face them at all, there are a number of successful cases of market-oriented exploitation whose success almost solely depended on their ability to find a solution for the emerging challenges once they occurred. *However, in most of these cases, neither risk nor emergency management were fully developed.* Instead, the partners and the project coordinator had to act without a strategy and managed to solve the problem in spite of their lack of preparation. It should be additionally noted that for example the replacement of a lost partner needed for a successful conclusion of research and exploitation processes was not fully supported by the Framework Programmes' rules. Because some of the organisations investigated were not fully aware of the need for risk and emergency management (and not prepared to act accordingly), and the rules neither facilitated nor demanded it, some projects did not manage to tap their full economic potential. In other cases, the success was only safeguarded by the flexibility of EC services to 'bend the rules'. Even in cases like these, the results were significant delays.

Management as an impact factor

- → project coordinator can only be as effective as the resources of his/her organisation allow him/her to be
- → ability of organisations and consortia to manage respective risks – and in the event of a risk becoming an actual challenge or threat: emergencies – is crucial for success
- → risk nor emergency management need to be developed and kept up-to-date

1.9.4. Market knowledge and awareness

Knowing who will buy a technology, product or service and under which performance or price conditions, is certainly a – if not the – major success factor for successful market-oriented exploitation. Every organisation that is involved in any type of R&D project and has an intrinsic motivation consider the economic potential of its research outcome will pay attention to what potential customers might want at some point. However, not every organisation is equally successful in doing so and the analyses conducted clearly indicate that there are several impact factors linked to market knowledge that decide whether or not the market-oriented exploitation processes were successful.

A first impact factor refers to timing, i.e. at which point it is 'best' to start thinking about market needs and market changes. Although, at first glance it seems almost irrelevant if the market knowledge has been acquired before or during the actual research project or subsequently during the innovation and exploitation stage, the *most successful organisations tend to investigate their potential markets quite early and often even before they develop a concept for a R&D project.* This comes as no surprise but it should be noted that the timing is usually linked to the type of research conducted. As most successfully exploited R&D projects were closer to applied than to basic research anyway, it is only logical that the organisations involved would be able to acquire the market knowledge needed much earlier and easier. Thus, conducting market analysis to acquire market knowledge at an early stage is not an option for all R&D projects and the participating organisations. Furthermore, with the Framework Programmes also funding more basic research and R&D projects aiming for platform technologies or radical innovations instead of innovative solutions for well-defined market needs, there might not be any form of definitive market knowledge about customers' needs etc. available at all. Consequently, there are a number of cases where a more general market awareness is part of the foundation for successful market-oriented exploitation. In sum, it seems safe to assume that *there is almost no R&D project successfully commercialised that has not been paying attention to the markets, both potential and pre-defined ones.* Even though the predictability of research outcome and thus, usability is rather limited, successful market-oriented exploitation will not likely be achieved without market knowledge or awareness.

Even if customer needs have been accurately defined, and the product or process meets these needs, commercial success depends on the ability of the exploiting company to market efficiently and effectively. The *marketing of products is a vitally important aspect of commercial success, and often neglected.*

A number of successfully commercialised R&D projects were designed and conducted along explicitly pre-defined *customers' needs*. These needs do not tend to change (much) over the course of a research project and the subsequent exploitation processes, i.e. there is little external demand for modifications. Nevertheless, some of these cases had to *adapt their research, innovation and exploitation strategy according to unexpected research outcomes*, which made additional market analyses necessary and advantageous. An even greater number of cases analysed were designed along either more general market needs or technological opportunities, i.e. they were not able to align their exploitation processes to some sort of market knowledge provided externally and a priori. Still, market knowledge proved to be an essential success factor and was often acquired at the earliest stages of the R&D project that produced the outcomes for which the market knowledge would be relevant. In many cases, the market knowledge was a rather undefined market awareness at first that – by adding respective market analyses – was transformed into knowledge about more definite market and customer needs over time.

There are a number of different sources of market knowledge: customers, market analyses, external consultancy, and advice from the European Commission through project officers or exploitation seminars etc. With regard to the positive impact and contribution to a successful market-oriented exploitation they cannot be discriminated as they are rather linked to types of R&D projects – or research – than to levels of success. However, all potential sources of market intelligence and knowledge have to be based on market awareness of research consortia and organisations involved in collaborative research, respectively. *External expertise, which is often provided by professional analysts not involved in the actual research and sometimes by representatives from the European Commission, seems to be most effective whenever an unexpected research outcome was produced,* a customer (or the customers) originally interested in the research outcome had to 'withdraw', or the organisations involved were about to enter an entirely new market with whatever they planned to exploit commercially. However, external consultancy was also widely used for it simply helps to widen the perspective, thus creating additional potential for market-oriented exploitation. Adding an external perspective to avoid lock-in effects is a general feature of successful research projects and market-oriented exploitation processes.

As both research and markets are highly uncertain environments to manoeuvre in, *any market knowledge is only as useful as it is up-to-date and fed back into the research and exploitation processes*. Success stories of market-oriented exploitation of EU-funded R&D projects in industrial technologies are almost always characterised by a constant feedback-process between market analyses and research. Thus, it is safe to assume that market knowledge cannot develop its full positive impact on market-oriented exploitation unless the R&D project's concept and governance mechanisms allow for modifications according to its input throughout the process. Being a major success factor, a combination of outside expertise and having a designated market analysis or exploitation work package within the R&D project were found to be most promising. Involving customers as a means of constant validation of the research's relevance for economic utilisation was also identified as successful approach but – as mentioned above – might not be an available solution.

Regardless of the sources of market knowledge and the design and implementation of feedback loops between market knowledge, research and market-oriented exploitation, *the ability and willingness to act flexibly (as either a group of organisations or an individual one) not only supports success in commercially exploiting research outcomes but in some cases facilitates a multiplication of applications and thus, potential customers, and reduces economic risks by diversification*. Successful exploitation processes are often linked to the flexibility to commercialise not a full innovative system but elements of the system if the markets or customers are not willing or able to procure the former.

As market knowledge (like knowledge in general) is tacit and individual / personal attitudes can determine the success of market-oriented exploitation human resources are key to successfully connecting market knowledge with research. There is evidence that successful R&D projects that have produced marketable innovations failed to deliver 'just' because key personnel has left the organisation regardless of the reasons (reorganisation, bankruptcy, job change etc.). The effect of human resources on successful market-oriented exploitation is also linked to the customers' but also the knowledge producing organisations' capacity to absorb the knowledge and innovations developed. Thus, training one's own personnel and customers (regardless of their participation in the R&D project) proved to be most effective for some cases.

Market knowledge and awareness as impact factors

- → knowing who will buy a technology, product or service and under which performance or price conditions, is *the* success factor for successful market-oriented exploitation
- → most successful organisations tend to investigate their potential markets quite early and often even before they develop a concept for a R&D project
- → adding external perspectives on market opportunities is highly effective, especially when unexpected research outcome was produced
- → the ability and willingness to act flexibly on well-defined strategies in some cases facilitates a multiplication of potential applications and thus, customers

1.9.5. Additional R&D

No research project – successfully commercialised or not – is a complete stand-alone event or process. They always resort to R&D results from the past, have links to parallel innovation projects and affect R&D and innovation processes in the future. However, it would be misleading to simply reduce these links to stating the research and its successful market-oriented exploitation is just part of a continuum. The fieldwork conducted during the study at hand clearly showed that there is a majority of success stories for which other, additional activities are the very basis for their success. Thus, it is important to understand that research and innovation processes almost never occur 'out of the blue' but have predecessors and successors, reusing or re-combining existing knowledge and thereby, generating new knowledge and technologies. For a number of cases the importance of parallel or even accompanying R&D or innovation projects opening up new and additional opportunities or pathways needs to be emphasised. In many of these cases research in the past, in accompanying or follow-up projects established ties with partners who later played a decisive role for successful market-oriented exploitation. Not limited to but primarily for more basic research projects, there is also evidence for the *importance of follow-up projects, simply because their research outcomes are often far from being ready for prototyping or other activities relatively close(r) to a market launch*. The importance of follow-up projects primarily refers to the need to advance a research outcome to become a marketable technology, product or service.

In general, additional research- or innovation related activities are common among successful market-oriented exploitation case studies but not in all cases do they present themselves as distinctive projects, i.e. almost every market-oriented exploitation is linked to another research project via some sort of activity transforming the outcome into a marketable innovation. It simply is not possible to exclusively assign new knowledge to one specific project. Public funding for any type of additional, accompanying or follow-up projects increases the success rate significantly.

Additional R&D activities as impact factors

→ investing time and financial resources into the advancement of a technology or innovative modifications of up-/down-stream technologies to an innovation is often the only way for a R&D project to be successfully exploited in the market

1.9.6. Organisational changes

It has been discussed in the pathway categorisation chapter (see chapter 4.3) that innovations and especially radical ones tend to have a structural effect on the organisations involved. The fieldwork provides evidence for an *inevitable adjustment of organisational structures, already established production processes etc. that comes with new and innovative technologies.* Sometimes, these adjustments are primarily of a technological nature that translates into organisational change. For other cases, the novelty of a technology creates a situation where the incorporation into the organisation would simply not work (e.g. if a technology adds the opportunity to engage in a completely new business area). Building new organisational structures such as new departments or even establishing spin-offs or spin-outs prove to be very effective in solving the organisational 'dilemma' and often enable or boost market-oriented exploitation. Also specific sales strategies or modified business models are sometimes needed to be established – within an existing company as well as in the case of a newly established department or spin-off. Outsourcing the market-oriented exploitation in a new or in fact external part of the organisation is also very effective for organisations that are fundamentally non-commercial (e.g. universities).

Organisational change as an impact factor

→ the market-oriented exploitation of innovative technologies is sometimes hindered by an organisational bottleneck and thus, the ability to bypass such bottlenecks by means of organisational change (spin-offs, new departments) is often underestimated as a key element (prerequisite) of market success

1.9.7. Dissemination

Within the process of market-oriented exploitation dissemination activities proved to have a positive effect on the success, especially if the research is less bound to well-defined customer or market needs. Regardless of the type of organisation *engaging in the exploitation, activities such as conferences, trade fairs, workshops, publishing of research outcome etc. are often key to establishing contact to potential customers or other organisations that can provide essential (missing) elements of an innovative technology* developed that ultimately enable market-oriented exploitation. In general, a successful take-up of more radical innovations (i.e. innovations so radical that there is not yet a fully developed demand or market) produced benefits strongest from any type of activity that creates publicity for that technology. In addition, dissemination is most effective when not limited to the final development stages of an innovation; thus enabling feedback and adaption.

Case 9: *One company coordinating a project presented a poster on its project work (a platform technology) at a conference and got in contact with another company (not part of the consortium) presenting a poster on an application. They identified a joint exploitation potential of their applications and in the end they joined their applications to a new product.*

Dissemination as an impact factor

→ actively disseminating the research outcome through conferences, trade fairs, workshops, publications etc. sometimes provides the only possibility to get feedback on the economic potential and recommended market-oriented exploitation pathways

All project consortia funded under FP6 were obliged to develop and update a so called 'Plan for Using and Disseminating the Knowledge' (PUDK), wherein they had to indicate their (potential, and at later stages, actual) dissemination activities. The type of dissemination activity varies according to the type of research (e.g. basic research often result primarily in publications and conferences) and of course depends on the orientation and interests of the participating organisation. Being scarce in numbers and highly diversified in quality, the existing PUDK provided only little evidence thereof. However, the case studies analysed show that those who drafted, updated and acted on their PUDK as well as their internal dissemination strategies were significantly more successful than those who did not. There is evidence that 'self-monitoring' of the project by actively using the PUDK contributes to a better governance of dissemination and exploitation processes. Nevertheless, projects that performed above average regarding their research were 'easier' disseminated and consequently, 'easier' commercially exploited.

1.9.8. Markets and demand

Although there are a number of successfully implemented strategies to create or at least increase demand for an innovative technology, product or service based on an EU-funded R&D project, *there is no evidence for successful market-oriented exploitation in not yet existing markets from the cases analysed.* While demand can be managed to some extent, the existence of potentially relevant markets appears to be a prerequisite for successful market-oriented exploitation. *However, there is an impact factor of demand that is not manageable: the overall economic situation/climate*, which ultimately translates to the general availability of financial resources. It is maybe the most important impact factor simply because investments and follow-up investments are necessary to either commercially exploit or apply whatever innovative technology, process etc. has been developed during or following a research project (regardless of whether it has been funded or not) and for customers to be able to procure such a solution. The general perception of innovations being less affected by weak overall demand is certainly true for a minority of success stories. Still, even the prospect of increased productivity created by an innovation purchased did not prove to be attractive enough in most cases affected by a weakened overall demand. *Successful market-oriented exploitation was achieved by those exploring other application opportunities, marketing small-scale innovations instead of fully-fledged system innovations, or simply persevering until at least some sectors recovered and demand increased again.*

In many cases, successfully exploiting research outcome economically is linked to the *ability to manoeuvre in markets dominated by customers – especially large enterprises – being reluctant to purchasing innovations.* The majority of organisations investigated act as suppliers to larger companies and in doing so their success in selling innovations depends on their ability to handle the particularities of their customers. Producing medium- to high-tech products and services on a larger scale, the majority of customers favour manageable production processes over new materials, technologies or processes that might require additional attendance, newly designed interfaces between different parts of the production sequence, reduced production capacities during installation or set-up stages etc. *Organisations that successfully commercialised their research outcome show two main characteristics in this regard: (1) they possess an almost intimate knowledge of the production processes and challenges of integrating an innovation in particular production chains and (2) they are able to actively convince their customers of their innovation's advantages and easy integration.* Thus, success in market-oriented exploitation is most likely when the supplier of an innovation and its potential purchaser have a long-term and close relationship as supplier and customer. Without such strong bonds, success becomes much less likely. In cases where a company successfully developed and sold an innovation to a customer it had no direct and close ties to before, there is usually little to no competition for the supplier and the customer was involved in the R&D project, accompanying the whole development process. In any case, the timing of a release seems to be most relevant. Even if the supplying and purchasing organisations have had a long-term and close relationship, the investment cycles of the purchaser (again, especially large enterprises) have to be met, unless, of course, the developing and supplying company manages to find another application area or market.

Whatever the reason might be, some industries are apparently simply not able or willing to purchase and integrate innovations at the same speed research and innovation projects could provide them. In those cases, successful organisations involved in EU-funded R&D projects tend to commercially exploit parts of what they developed, marketing their innovation 'bit by bit', sometimes even 'hiding' an innovative characteristic or feature to the customer in order to avoid rejection due to reluctance (as discussed above). For example, in nano-electronics the global suppliers and manufacturers follow a road-map and any introduction of a new higher fidelity technology is delayed, due to substantial manufacturing plant build or process line modifications.

> ***Case 44:*** *A company that was responsible for one of the work packages and at the same time the project coordinator has a long-term supplier-customer relationship with large enterprises from the automotive and aerospace sector. Their successful market-oriented exploitation was based on their excellent knowledge of the customers' needs (regarding innovative technological solution and their performance) but also of their peculiarities. Although their customers are widely perceived as being open to innovation and eager to implement new and improved production processes and techniques, they actually favour stable and unchanged production processes over innovation. Thus, the company – developing control systems and algorithms – emphasised the ease of integration of their innovation over its superior performance while marketing it. In fact, the company sometimes goes to such lengths as to actively 'hide' certain new (i.e. innovative) features or opportunities of an algorithm.*

In sum, the reluctance of markets, industries or individual companies to purchase innovations as well as lack of financial resources often leads to a situation where a *need* (that was identified before or during the R&D project and formed the basis for research, development and the market-oriented exploitation processes) *does not translate into an actual demand.* Thus, only those R&D projects and market-oriented exploitation processes become successes that manage to actively trigger the demand or evade a deadlock by changing the innovation or targeting different markets, industries etc. In general, larger companies tend to be better equipped to do the former while SME are more apt to switch to another market, exploit small-scale innovations or identify niche markets for their innovation not attractive for larger companies. As innovations are by definition new and no or little is known of how they will perform in large-scale production or use, the benefit perceived by the potential customer is often lower than the actual benefit, and the perceived costs higher than real costs. Successful market-oriented exploitation thus often includes smart marketing that changes this perception.

Demand as an impact factor

→ even the best-prepared and –executed market-oriented exploitation process fails if the demand is not there or not strong enough, which can have a number of reasons from the overall economic climate to a mismatch between innovation and investment cycles

→ organisations that successfully commercialised their research outcome possess an almost intimate knowledge of the production processes and challenges of integrating an innovation in particular production chains and are able to actively convince their customers of their innovation's advantages and easy integration

1.9.9. Internationalisation and international competition

Developing for and marketing on internationalised markets is an issue to most market-exploitation processes analysed. However, it not equally relevant for all organisations since some of them are or claim to be without serious competition neither from competitive technologies nor organisations. The necessary advantage to avoid direct competition often stems from the R&D project in question. While it is also one of the main obstacles to be overcome (i.e. developing a product or service for largely undefined markets), it certainly is a success factor when the organisations involved manage the challenges arising from this situation.

Nevertheless, most results of market-oriented exploitation based on research face fierce international competition. Innovations are clearly not selling themselves and – as the discussion on why needs do not necessarily translate into demand has shown – even radical innovations that were developed as an answer to a well-defined technological or market need depend on their price as much as on their performance (or, in fact, even more on the price than on anything else). This still holds true even if the consortium involves the very customers that demanded the innovation in the first place. Another crucial success factor is – as often – timing: *international competition does not only affect prices but is a constant source of potentially competitive (or even the same) technologies.* Only in very few cases analysed the exploiting organisations were in a position where they were not worried about somebody else – primarily outside Europe – developing the exact same or a comparable technology at the same time. While European competition generally seems to be less important for most companies involved in EU-funded R&D projects, there is the issue of Asian and US-American companies getting to the markets faster even in case where their research started later. In some cases, the research consortiums respond by deliberately downgrading their innovations;

thus, simply making them cheaper but also reducing the time needed for fully developing a marketable innovation. *Apart from downgrading innovative solutions by commercially exploiting a less radical innovation, organisations sometimes deliberately decide to down-scope by focussing on rather small-scale innovations instead of large-scale innovative systems.* Successful market-oriented exploitation is not necessarily based on intelligent downsizing or down-scoping but the ability and flexibility to apply one of the two or even both principles. This has certainly helped many companies investigated in avoiding price erosion from its (potential) customers or securing a competitive advantage by being first on the market.

However, the discussion on the importance of matching the timing of innovations being marketed and the investment cycles especially of large enterprises shows that it might not be solely about being the first but about being there at the exact right moment, which is – of course – hard to achieve. There are two strategies to be found among successful examples of market-oriented exploitation that help *coping with the timing issue*: (1) *involving large enterprises* in the R&D project generating the basic research outcome and allowing them to govern parts of the project, and (2) *establish and maintain close ties to large enterprises* as research partners, customers etc. Organisations that do not have either (e.g. because they are start-ups or only start to develop for and sell to large enterprises) were only successful when they managed to access this kind of knowledge through either another consortium partner or an external expert.

> ***Case 32:*** *For some companies interviewed the commercial success (not the successful market-oriented exploitation) is (still) entirely dependent on one single large (potential) customer whose uptake of the technology, product or service could create not only an immense market pull but a de-facto standard. Still, they manoeuvre on largely unknown territory (new markets) and their links to this customer are often indirect at best. Thus, their actual market penetration is pending and it is not in their power to accelerate the process.*

In general, international competition has a more profound impact on the pathways of market-oriented exploitation and its success whenever the target market is global; organisations that target Europe exclusively seem to be much less affected. Based on the field work conducted it is however not clear if this is a sometimes strategic decision to avoid competition. However, there are a number of reasons for organisations to internationalise their target markets and cooperative relations. For example: much of today's (mass) production is taking place outside Europe and innovations developed for production processes will often have to prove their value there. Successful market-oriented exploitation in such cases is linked to market knowledge regarding non-European markets and the ability to be flexible about what could be marketed in different regions.

> ***Case 20:*** *Due to the economic crisis typically strong markets for expensive construction materials (e.g. marble) in Southern Europe collapsed completely. Any technological innovation in handling these materials was no longer saleable and the companies involved in a respective EU-funded R&D project and subsequent market-oriented exploitation had to focus on their – until then – ancillary market: the Middle East. Still, they had the required market knowledge and direct connections to the markets, which was pivotal.*

Being flexible enough to downgrade or down-scope an innovation is vital as long as there are markets with different framework conditions, e.g. labour costs are lower in North America, and even lower in Asia, and the increase in productivity by using an innovative technology might not be as relevant there. More precisely, the cost-benefit-ratio of purchasing comparably expensive yet more productive machinery etc. is often different. Nevertheless, some success stories were directly linked to companies shifting their attention from the European market elsewhere.

International competition as an impact factor

→ international competition does not only affect prices but is a constant source of potentially competitive (or even the same) technologies

→ uncertain price developments make it vital to develop and act on a flexible strategy that allows downgrading an innovation if prices are too low to market an innovative system cost efficiently or use different marketing approaches for different (geographical) markets

1.9.10. Standardisation and regulation

While technical standards are sometimes seen as hindering innovation (e.g. through lock-in effects or agreeing on least common denominator instead of the most innovative solution) they can also have a catalyst function for innovation. So called smart standardisation can be a knowledge and technology transfer channel and can enable or facilitate the practical implementation of research results. Smart standards and regulations define required performance criteria instead of detailed technical specifications, which leave room for alternative technologies and business models. Smart standards rather promote innovations (i.e. marketing by creating critical mass or getting support of relevant stakeholders, accelerating the diffusion of innovations) than generate innovations. In principal standardisation can be characterised through broad/open access. One key aspect is the voluntary process of developing technical specifications based on consensus among interested players (bottom-up 'self-regulation').

Despite its theoretical relevance for the processes analysed, there is no empirical evidence that standardisation is a strong impact factor for successful market-oriented exploitation. The main reasons are that the *integration of R&D and standardisation activities is still an exception (in both companies and research organisations)*, there is too little awareness for the potential benefits of standards and the access to standardisation committees is not easily achieved (in particular for SMEs and researchers from universities). However, *informal standards play a vital role for the case studies analysed. Some technologies developed opened up new markets or niche markets, which – by being the first and at least for some time the only supplier – creates a quasi-standard.* Still, there seems to be little awareness that even a first-mover advantage might not last long enough to create an effective standard and sufficient return-on-investment. There have been examples in the past where a more innovative quasi-standard has been overruled by less innovative standard (e.g. the implementation of the VHS standard against its superior competitors).

In contrast to missing evidence for standardisation as a success factor, there is some evidence for its top-down 'sibling'; regulation. However, *regulation is most prominent as an impact factor due to its absence*, or more precisely due to the absence of the 'right' form of regulation to boost different technologies. In some cases, especially where the market-oriented exploitation was successful but the demand is not strong enough, technology developers complain about the *lack of regulatory push*.

> ***Case 15:*** *While all steps of the research and innovation process were conducted successfully, i.e. the technology targeted was developed, transformed into a prototype and successfully validated and tested, the demand remained weak. The consortium even managed to attract a follow-up project that allowed them to build a number of demonstrators and develop a business model to ease the economic success further. However, their final (i.e. the second, now including the business model) market launch did not result in an increased demand due to the global recession. Even though their project received awards and above-average publicity, and enables purchasers to label the implementation (and thus, their company) as being 'green', the markets did not take up the technology. Investments in sustainable, green infrastructure that would only be economically justifiable in the long-term (i.e. by assessing the lifecycle costs) were not available to most customers.*
>
> *Thus, the companies' hope now rests with a national or even European regulation being established that would somehow make their technology more attractive.*

Whenever radically new technologies are developed there is sometimes a lack of regulations, simply because regulation as a top-down process is rather conducted in response to the emergence of new technologies. Within the cases analysed the (perceived) lack of robust, enforceable regulations does not impede the market-oriented exploitation completely but can make the difference between a product's sales remaining at the market entry level and becoming a massive success.

Standards and regulation as impact factors

→ informal standards play a vital role for the case studies analysed. Some technologies developed opened up new markets or niche markets, which – by being the first and at least for some time the only supplier – creates a quasi-standard

1.9.11. TIMING

The right timing is both nearly impossible to define and crucial to successful market-oriented exploitation at the same time. *While it cannot be defined as it is different for each innovation it became clear from the case studies that more than one promising, feasible, valuable innovation was not commercialised (as planned) due to bad timing*:

- Innovative technologies, products or services were commercially launched in the midst of the global crisis of the financial markets and/or the subsequent economic crisis
- Innovations could not be launched before a competing organisation or technology launched their comparable solution
- Consortiums and organisations established their markets very early and their market-oriented exploitation processes were not designed to account for market changes
- Market awareness and market knowledge did not play an important role for the research and innovation process for the most part and when it was

introduced as a relevant criterion it was too late (e.g. a competing technology was already available) or lead to substantial and critical delays

- Investment cycles of a potential purchaser (especially large enterprises) were not met because the innovation and investment cycle were not matched
- International competition did launch their technology (similar or comparable) innovation first

1.9.12. Patenting and risk capital

There is an increasing focus on intellectual property in general and patenting in particular as an essential part of the market-oriented exploitation of technologies emanating from universities and public research institutes. In the context of commercialisation of public sector technologies, the existence of a patent or patent application is frequently a prerequisite to attract risk capital, as there are few other possibilities to evaluate the business potential of early stage technologies. Risk capital in the form of pre-seed and seed funding is often needed to develop such inventions towards the market, regardless of whether this takes place through licensing or if a spinout company is established around the technology for this purpose. As patenting of technologies in the public research setting is strongly related to risk capital both can be viewed as impact factors for commercialisation. When assessing Framework Programme funded projects it would, given the heavy involvement of public sector research organisations, be natural to assume that consortia viewed risk capital as an important issue, but apparently it is not so.

While the intellectual property survey of this report identified that pre-selected projects had indeed generated patents/patent applications, many of the other sample projects had not. Adding to this, empiric results from the case studies and interviews relating to projects carried out under FP4-6 clearly indicate that *the consortia did not see intellectual property as an important issue. Moreover, there is very scanty evidence of patent applications with inventors belonging to different organisations of the research consortia.* This is in accordance with the finding that the bulk of analysed EU-funded R&D projects can be assigned to the type of market-oriented exploitation labelled 'direct knowledge transformation' requiring additional research activities, and that this then largely dominates the overall analytic picture. Recalling that characteristics of this type include non-linearity, complexity or the notion of pathways of market-oriented exploitation as being full of set-backs, feedback loops, side-tracks and so forth, this is in stark contrast to the generation of patentable technology, which demands novelty, well-defined technological traits, legal certainty, clearness regarding inventorship and ownership, and so forth. It appears, then, that claims of intellectual property by consortia partners would be ill-placed in the context of 'direct knowledge transformation' requiring additional research activities and it is probable that such demands would actually hamper the progress of the research project.

Furthermore, the fact that the consortia view *risk capital as being of no particular importance* harmonises with the conclusion that the lion's share of market-oriented exploitation under FP4-6 is of the non-linear type; risk capital investments target objects that progress between clearly defined milestones along a linear development route towards the market, according to an agreed pace. The investment decision will in most cases also be founded on the existence of proprietary technology and associated IPR, neither of which has been noted to be particularly important for the consortia in the framework of type 2 market-oriented exploitation.

In projects where patents/patent applications have indeed been generated no venture capital is needed, as they have been part of corporate commercialisation efforts, a process that will have been financed by the company's own R&D budget. Virtually all patent applications identified were filed by companies, and if this situation can be extrapolated to the totality of projects carried out under the three framework projects, it would mean that the *ratio of university to corporate innovation/patenting activities is very low.* University patents are a proxy for risk capital, which then also explains its lack of importance in the context of FP funded projects.

Patenting and risk capital as impact factors

→ intellectual property was not an important issue for organisations involved in the market-oriented exploitation, neither as a problem during the research stage nor as part of actual exploitation
→ there is very limited evidence for patent applications with inventors belonging to different organisations of the research consortia
→ risk capital was also of no particular importance

1.10. TYPES OF IMPACT FACTORS

The fieldwork conducted identified a number of impact and success factors for the market-oriented exploitation of research outcome. In order to structure the findings and transform them into aggregated knowledge, the research team developed an approach to categorise the impact factors and systemise their effects. It primarily follows two systems of categorisation: joint characteristics (such as referring to the types of organisations involved or the characteristics of the research itself) of impact factors and their relevance in the three main stages of innovation and market-oriented exploitation processes (research, development and exploitation). In this context, relevance refers to the impact on the pathway and success of market-oriented exploitation. The following Table 3 displays the result of this effort.

When analysing the relevance of impact factors as displayed by the colour scheme it becomes evident that *most of the impact factors are relevant for the research and development stages.* While it may not be surprising as such it shows that, although some of the most crucial impact factors such as market demand 'enter' the R&D and market-oriented exploitation process rather late, the 'fate' of such processes is decided much earlier. In addition, *many impact factors' effect stretches across all three stages of an innovation cycle*, e.g. the participation of customers in a R&D project tends to be very relevant throughout the whole research, development and exploitation process. Some impact factors are so basic that their relevance and effect do not even vary in the slightest over the stages of the innovation process (which, in fact, can span several years, sometimes up to 15 or more) such as the ability to act flexibly according to whatever changes and challenges occur. As several impact factors do not lose their relevance over time – although the effect might be changing – while others are 'only' relevant in certain stages of the processes from research to market-oriented exploitation, it is most important to understand that this in no way qualifies as an assessment of the overall impact. On the contrary, some of the impact factors that are only relevant during the last stage such as market demand, regulatory push, price erosion etc. are among the most effective ones.

TABLE 3 MAPPING IMPACT FACTORS AND INNOVATION PROCESS STAGES

Dimension	Impact factors	Relevance in different stages		
		Research	Development	Exploitation
Type of R&D and innovation	Type of research (basic vs. applied)			
	NMP split			
	Type of research outcome (e.g. platform technologies)			
	Public perception / opinion			
	Level of novelty (e.g. scientific breakthroughs, radical innovations)			
Consortia and cooperation	Industry participation			
	SME participation			
	Customer participation			
	End-user participation			
	Vertical integration (value chain)			
	Large Enterprises participation			
	Involvement of competitors			
	Commitment and activity of partners			
	Drop-out of partners			
Management and governance	Project coordination			
	Project and scientific officers			
	Risk and emergency management			
Market knowledge and awareness	Market knowledge			
	(Timing of) Market analyses			
	Market awareness			
	Alignment to customers' needs			
	Ability to modify exploitation strategies according to market and technology observation			
	External market expertise			
	Feedback between market knowledge and R&D			
	Ability and willingness to act flexibly			
	Tacit knowledge			
	Absorptive capacity			

Additional R&D	Accompanying R&D and innovation projects			
	Prior R&D and innovation projects			
	Follow-up R&D and innovation projects			
Organisational changes	Ability and willingness to adjust organisational structures			
	Building new organisational structures			
Dissemination	Comprehensive dissemination activities			
	Up-to-date dissemination strategies (e.g. PUDK)			
	Self-monitoring along PUDK			
Markets and demand	Overall economic climate			
	Market and customer peculiarities			
	Knowledge of customers' production processes			
	Power of persuasion, ability to sell innovations			
	Timing of market launch with regard to investments cycles etc.			
Internationalisation and international competition	Price erosion			
	Timing of market launch (i.e. being first or finding the exact right moment)			
	Ability to flexibly commercialise according to different market conditions			
Standardisation and regulation	Defining (temporary) quasi-standards through first-mover advantages			
	Regulatory push			

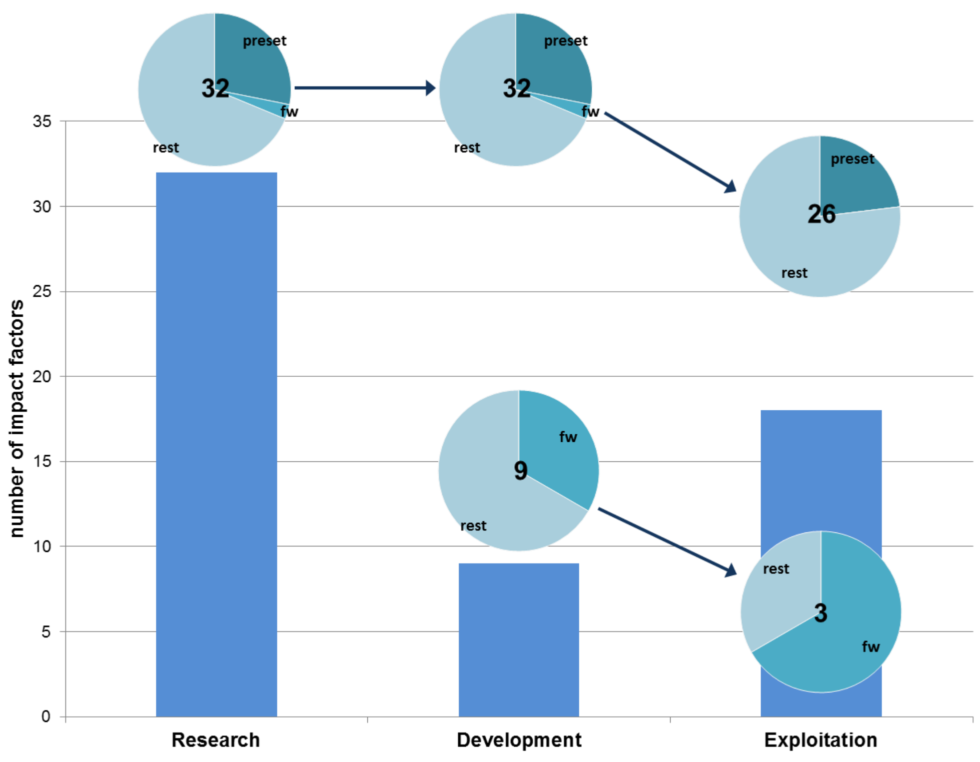
Source: Austrian Institute for SME Research 2012

Annotation: The colour scheme used refers to the level of relevance of the different impact factors for the three main stages of innovation and exploitation processes, from white = not relevant to graduations of blue = somewhat relevant to highly relevant. However, it is important to note that this in no way qualifies as a quantitative ranking but a Likert-scale type of ranking of subjective perceptions and qualitative assessments by individuals interviewed.

It needs to be emphasised that a number of impact factors are much more an integral part of the R&D project than part of the events and actions that require actual management decisions by any of the organisations involved. For instance, the case studies show a correlation between the type of research conducted and the success rate, i.e. applied research is commercially exploited more often, much faster, more easily etc. than basic research. However, the decision to engage in either applied or basic research is a general one that might have numerous effects but cannot be changed afterwards. The same holds true for the NMP split: although it is a conscious decision to engage in nanotechnological research and it has a profound effect on the pathway, the obstacles and the overall likelihood of successful market-oriented exploitation, it is not the kind of decision and management behaviour that can be analysed in order to strengthen the knowledge about how research can be successfully transformed into economic effects. Such impact factors are integral parts of the basic decision to conduct certain types of R&D projects. Everything else – from selecting partners for a research consortium to agreeing on commercialisation strategies and acting on them in a flexible and intelligent manner – is not only relevant but holds lessons to be learned.

The following Figure 9 shows the distribution of impact factors between the different stages of the innovation cycle or – to be more precise – shows how many impact factors become relevant for the first time in which stage. Therefore, it confirms and emphasises the assessment that *by far the largest number of impact factors emerge as relevant in the early stages of R&D projects and their market-oriented exploitation processes.* Observing these impact factors and acting accordingly predetermines and shapes the pathway of market-oriented exploitation (and the probability of successfully completing it). Almost all impact factors that emerge first in the research stage sustain their impact throughout the innovation cycle and not because they all are pre-set impact factors, i.e. impact factors resulting from decisions to conduct a specific type of research or project. In fact, more than ¾ of the impact factors and their influence can be affected by the organisations and individuals involved. *However, the fact that during all stages new impact factors emerge illustrates that while decisions during the research stage set (determine) much of the path, efforts to respond to changes and challenges in a meaningful manner is a constant issue.*

FIGURE 9 IMPACT FACTORS ACROSS STAGES OF THE INNOVATION CYCLE



Source: Austrian Institute for SME Research 2012

Annotation: The columns indicate the number of impact factors and their first 'appearance' during the three main stages of the innovation cycle, e.g. 32 impact factors were identified as being relevant during the research stage for the first time and some 18 during the exploitation stage. The pie charts indicate the classification of impact factors as pre-set (constituted in the beginning of the conceptualisation), framework (fw) (thus, not easily affected) or rest (those that can be influenced throughout the project or at least during the stages of innovation cycle they are relevant for). The pie charts additionally indicate the number of impact factors relevant and their (relevance) transfer to the next stage, i.e. of the 32 impact factors identified as relevant during the research stage, all 32 extend their impact to the development stage and 26 are still relevant during the exploitation stage.

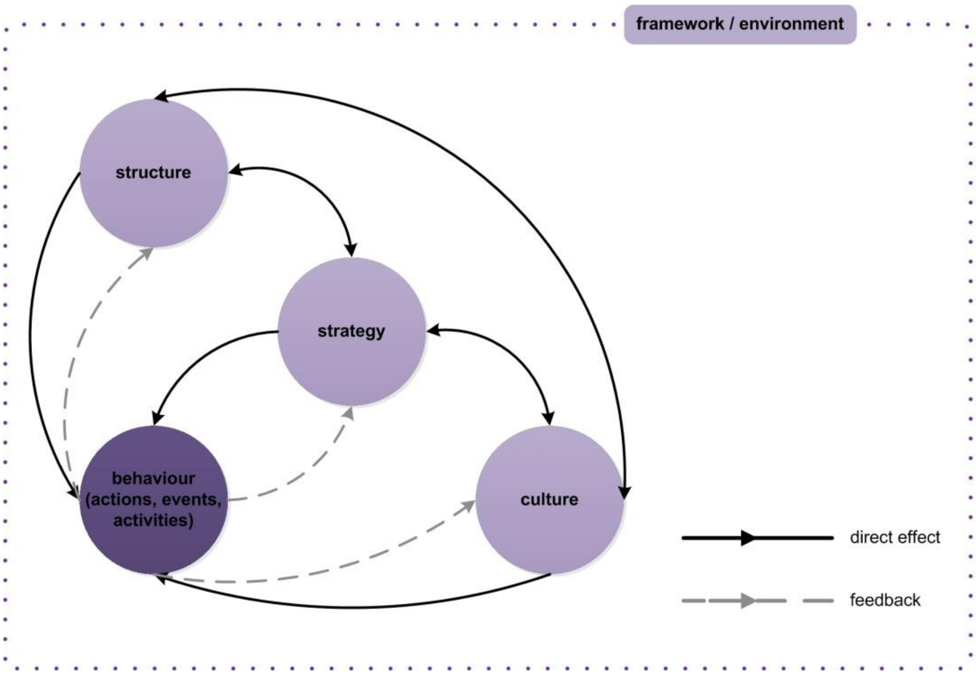
Still, the proportion of impact factors that oppose influence from organisations or individuals because they are part of the pre-set structure or the framework conditions is lowest in the research stage and highest in the exploitation stage. Thus, the *chances to successfully affect the research and market-oriented exploitation processes are highest in the beginning of an innovation and exploitation process, i.e. when designing and conducting a R&D project.*

In sum, a first type of impact factors comprises those that are directly linked to characteristics of whatever research is being conducted but belong to the 'starting point' and not the innovation and exploitation processes despite their structuring effects. However, there are some structural factors that are very well based on conscious decisions within the research, innovation and exploitation cycle although many of these are usually being made in the conceptualisation stage. The most prominent in terms of effectiveness refer to the composition of the research consortium, from including SMEs as fast-moving, niche-seeking organisations, to large enterprises and their market power or customers that help to safeguard the exploitation orientation of the project and often the actual market penetration by acting as avant-garde customers. These impact factors determine the activities of the organisations in terms of both possibilities and necessities by creating path dependencies; thus, strengthening the impression that the course of any R&D project and its exploitation is set very early regardless of how many influential actions, responses, decisions occur much later in the process.

Apart from the basic structure and main pathway already predefined or predetermined by the type of research, the consortium conducting the research etc. there are a number of impact factors that refer to the ability of organisations to develop plans and strategies and act on them but in a flexible manner such as having a dissemination and exploitation strategy already early-on (but allowing for modifications whenever necessary) or strategically using market knowledge as a steering mechanism for research, development and market-oriented exploitation. In addition, the pathways are influenced by (organisational) cultures and (individual) attitudes such as the commitment to cooperation. All of the above are basically sources for activities and actions that were identified as affecting market-oriented exploitation of research outcome. Therefore, another category of impact and success factors includes behavioural impact factors, i.e. those that comprise actual actions and events.

In addition, there are two types of intermediary impact factors that shape the transformation of structural components of research and market-oriented exploitation processes into behaviour: organisational strategy and culture. All impact factors – categorised as structural, strategic, cultural or behavioural – have to be understood as being intertwined and mutually dependent (see Figure 10). In addition, they have been found to affect market-oriented exploitation in an almost infinite variety of combinations.

FIGURE 10 TYPES OF IMPACT FACTORS AND THEIR RELATION



Source: Austrian Institute for SME Research 2012

All the success factors ultimately depend on the right framework conditions to reveal their full impact, from customers being open to innovation, financial resources not being additionally hampered by an unfavourable global economic climate to legal regulations that favour innovative technologies and thus create (additional) market pull. In sum, *there is no success if the framework conditions, especially the market-related environment, are not favourable.* Some successful organisations managed to avoid unfavourable framework conditions, e.g. by switching to other markets, postponing the market entry or being content with knowledge spill-overs instead of a stand-alone market-oriented exploitation. For the majority such strategies were either not feasible or they did not have the knowledge or perseverance to do so. However, even if the framework conditions are more or less favourable, there is still a lot to be reckoned with and there are many impact factors that decide over the success of commercially exploiting research outcome.

Types of impact factors

→ a number of impact factors that are strongly affecting the success of market-oriented exploitation is linked to the type of research conducted and thus, cannot be changed or altered
→ although the most effective impact factors emerge such as market pull emerge in the later stages of the innovation process, the majority of impact factors emerge in the earliest stages and continue to affect the exploitation success
→ with every step further the pathway to successful market-oriented exploitation is less and less influenceable
→ primarily during the research stage organisations can prepare themselves for the challenges of market-oriented exploitation and thus, the earlier and more intense this preparation is being conducted the more likely is success in this regard

1.11. WHAT ABOUT 'OPEN INNOVATION'?

Open innovation practices were among the hypotheses on what might be driving successful market-oriented exploitation based on an increase in empirical evidence that open innovation is a major trend that is changing the mode of knowledge production and transfer. In general, there is no doubt that the pathways of market-oriented exploitation processes analysed show characteristics linked to open innovation. However, there are a couple of findings arguing against open innovation as being relevant for the cases analysed (and possibly beyond).

Elements and impact factors potentially linked to open innovation that were identified are not exclusive to open innovation or a new development as a whole, e.g. the involvement of customers (but not individual end-users) in the development of a new product, service or technology. Starting R&D projects by analysing the feedback from one's customers with regard to potential improvements of an existing technology etc. or their need for a new solution to a new problem (including a more efficient solution to an old problem) is certainly not a new development but the basic principle of entrepreneurial success. Basically, every research aiming for market-oriented exploitation can at least be linked to this principle. Collaborative R&D projects (usually involving companies and non-profit research organisations) are also not new and above all a basic principle and prerequisite for publicly funded R&D projects almost everywhere. The notion that collaboration as such becomes more important because no organisation has all the knowledge, equipment or experience needed to create new technologies etc. has been an established fact for many years. Moreover, judging from the analyses of pathways to successful market-oriented exploitation in EU-funded R&D projects collaboration seems to have a clear predetermined breaking point: whenever a research project creates results that promise economic benefits collaboration becomes less important or at least much less all-embracing. That is not to say that all cooperation vanishes but in most cases the network of collaborators becomes significantly smaller (usually limiting cooperation to partners absolutely irreplaceable and at the same time 'non-threatening' to one's own economic interests such as not-for-profit organisations or non-competitors). For instance, larger companies – that have the capacities necessary – sometimes extract commercially valuable research results during the project's duration and thus, limiting the access of their collaborators to this knowledge or technology. In addition, there seems to be little willingness to extend cooperation beyond the research stage in general. Especially companies guard 'their' work packages' results (usually EU-funded R&D projects are organised in different work packages assigned to different individual organisations or sub-groups within a larger consortium) against others especially when it comes to any form of market-oriented exploitation. *Instead of open innovation there is evidence of what might be called open research but even there are limits to the level and scope of openness* (see above).

However, it should be noted that many of the cases analysed produced evidence that the costs of sustaining a collaborative approach beyond the research stage are perceived as being simply too high. In addition, many customers seem to prefer small-scale innovations over large-scale innovative 'systems' anyway. Thus, the pull for extended, intensified cooperation as in 'open innovation' to provide a solution integrating innovations from different work packages of a larger R&D project is weak. A potential explanation for this finding is that while openness is easier when the innovation is more up-stream (i.e. all stakeholders would benefit), e.g. a platform or enabling technology.

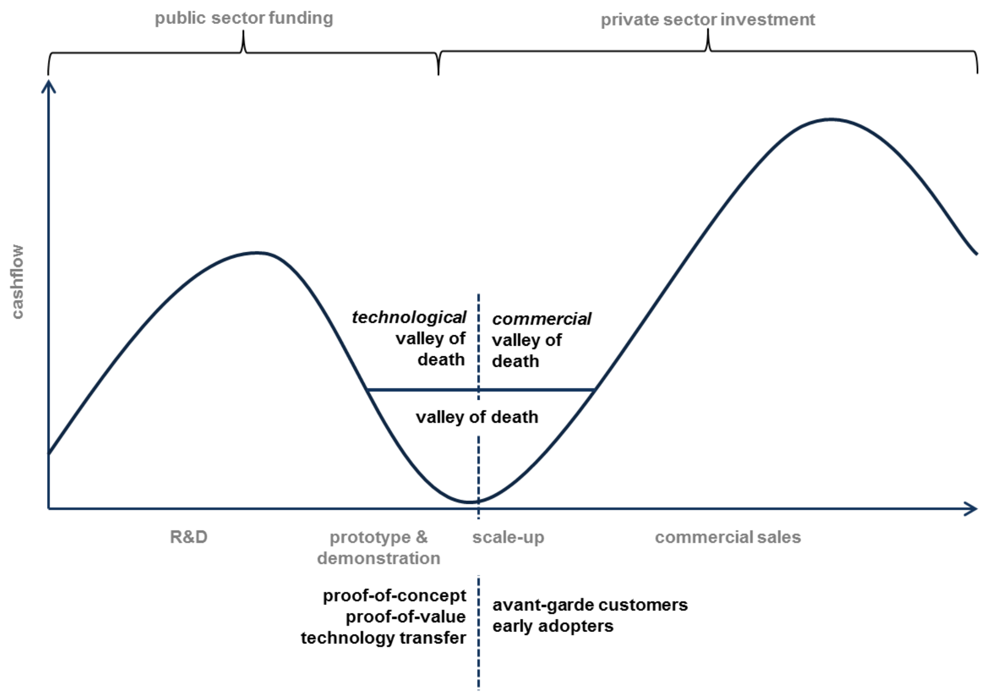
For more down-stream innovations (i.e. closer to customers) on the other hand openness would discourage investment in the area since the competitiveness would not be available as a driving force.

Furthermore, open innovation is (per definition) limited for R&D projects funded by the European Framework Programmes. The consortium partners are fixed from the very beginning and the project management is confined to maintaining the consortium in the form developed for the proposal and formalised with the European Commission. Thus, openness by going beyond the established consortium boundaries is limited. In addition, members of consortia are bound to their IPR agreements made at the very beginning of the research process and therefore, any ‘open innovation’ type approach along the research process is very improbable. *In sum, the Framework Programmes’ funding conditions do not seem to support open innovation to say the least.*

CONCLUSIONS

The aim of this study was to analyse how and why R&D projects funded by the European Framework Programmes managed to successfully exploit their research results to a positive economic effect (market-oriented exploitation). There is one term commonly used to describe what stands between any given research project and its successful market-oriented exploitation: the infamous 'valley of death'. The term is used to illustrate the severe setback in organisations' cash flow while transforming research outcome into products or services successfully penetrating the market endangering technologies, innovations and often whole companies. While public funding is not available for these later stages of the innovation cycle, private investments are not nearly sufficient for the earliest stages of commercial activities based on the innovation developed (see Figure 11). Private or public risk capital is designed to help organisations to survive through the valley death but it is – especially in Europe – not nearly as developed and extended as would be necessary. In the following, this phenomenon will be used to develop conclusions following the findings presented above.

FIGURE 11 VALLEY OF DEATH



Source: Austrian Institute of SME Research 2012

In general, *there is plenty of evidence that organisations involved in FP-funded research were quite successful in market-oriented exploitation*. The analysis of success stories (see chapter 4.2) of organisations involved in selected R&D projects and their pathways towards the market becomes more intelligible when the valley of death phenomenon is broken down into two main parts: the technological and the commercial valley of death. The former is more strongly related to a proof-of-concept stage, where the lack of financial resources is based on the fact that investors are at that point not customers (the technology is usually still too far from being a fully-fledged application, anyway) but risk investors, and that the risk of technological failure or proof-of-value failure is still too high to attract risk capital in larger amounts. Furthermore, the organisations it primarily affects are research organisations or universities that neither have sufficient financial resources nor the experience and expertise to complete the technology transfer, proof-of-value etc. It is this part of the valley of death metaphor where so many promising technologies are not being developed to their full application and economic potential – or even not at all.

In contrast, the success stories identified from the industrial technologies R&D projects in FP4-6 were not actually hampered – though certainly challenged – by this particularly 'lethal' part of the valley of death. In fact, the *commercial valley of death seems much more relevant and also not as hard to bridge but still embodying a number of reasons why an organisation might not tap the full potential of a technology developed*. It refers to the difficulties of attracting avant-garde customers or early adopters in the market; those customers that signal to the market that a technology is safe, performing well, can be integrated into existing production processes etc.

For the case studies analysed, the commercial valley of death is the most decisive obstacle that needed to be overcome for a successful market-oriented exploitation. It is here where all the late-stage, highly effective impact factors take effect: overall economic climate, price erosion, marketing and sales abilities, absorptive capacity of customers, ease of integration of an innovation into existing production processes, matching innovation and investment cycles etc. Although all these factors refer to either external or framework-related impact factors (market, customers, competition) or the internal preparation for and response to market impact factors, it is crucial to understand that the field work conducted managed to show one main mechanism of success in market-oriented exploitation: *although the most effective impact factors occur in later stages of the innovation and market-oriented exploitation cycle, most of the crucial decisions – including mistakes – are made in the earlier stages of such processes*. While there is no way to fully foresee the development of market and demand (and sometimes a new technology also means an unknown market), there are plenty of opportunities for the best preparation possible. For example, successful commercial exploitation is almost always linked to finding the right partners for a R&D project even if the market-oriented exploitation is conducted without cooperation. Only by bringing together a research consortium that allows for vertical integration and a maximum scope of economic applications, the economic value of research outcome is 'insured' against weak markets etc.

However, the technological valley of death exists and it is as relevant for industrial technologies as for any other field of research, maybe even more important. The apparent lack of evidence for its relevance for the cases analysed seems to have two main reasons: (1) the cases analysed were able to cover the technology development – including transferring knowledge where necessary – during the R&D project they were selected for by the research team. Thus, they did not have to face the respective threats without support and therefore, did not focus on that as the main issue of their market-oriented exploitation. In many cases, the R&D project was designed as an answer to a market or customer need and potential purchasers were deeply involved in the projects and often driving the research and development processes. Thus, they ensured that the research outcome's feasibility was the main indicator and criterion all along. (2) For many organisations the key to commercial success laid in follow-up projects, funded by either European, national or regional sources.

Initially, *two main types of pathways of market-oriented exploitation have emerged from the analyses conducted*. The first type ('commercial conversion' or 'commercialisation') is characterised by a direct and linear research exploitation aiming at the market and economic effects and is defined by the almost fully linear relation between the research outcome produced in an EU-funded R&D project and a technology, product or service available to the market. The second type ('commercial transformation') stands out due to non-linear patterns (i.e. substantial additions, modifications etc.). Cases of this type and thus characteristics as non-linearity, complexity or the notion of pathways of market-oriented exploitation as being full of set-backs and feedback loops are by far most frequent in the findings. Within this non-direct market-oriented exploitation group there is a large diversity of pathways to be found. The type 'commercial transformation' of research outcome in processes of market-oriented exploitation takes two distinct forms: direct market-oriented exploitation processes, where additional research outcome or additional non-research activities were integrated into or added to a technology, product or service 'dominated' by the NMP-related technology or research outcome and indirect market-oriented exploitation processes, where the research outcome (or parts of it) is merged into other technologies or research outcomes and the respective market-oriented exploitation processes (knowledge integration and spill-overs).

These types of pathways are partially predetermined by different elements of the setting of the R&D project. For example, the type of research or the composition of the consortium is inherent to the R&D project and predefines to some extent the pathway. These elements are of course impact factors for successful market-oriented exploitation but they result from a conscious decision in the beginning of the project (design) phase. Success then depends on the well-defined planning/strategy (i.e. when carrying out basic research, involving adequate end-users or when involving partners of various different disciplines, scheduling knowledge transfer facilities – such as workshops – carried out by a specialised partner etc.).

In other words, *some impact factors (mainly those with a more structural character) strongly predetermine the pathway from the research project to the market-oriented exploitation*. However, there are impact factors, which possibly have an influence on the shape of the pathway during the innovation processes. These impact factors emerge at different points during the project period and/or after the project. Some of them have a strong impact and some are less effective or they can be influenced themselves by the participants of the R&D project to a variable extent. For example, the unforeseeable drop-out of one or more partners can have a strong impact on the market-oriented exploitation, particularly when this partner has a crucial role (i.e. implementer of the technology). The (negative) impact increases when finding a new partner results at least in delays and/or result in simply no sufficient implementation. Furthermore, it depends on how the participants deal with such a situation. Not finding an adequate replacement of such a partner can mean that an originally direct and linear pathway becomes re-directed into a rather non-linear and indirect pathway, e.g. due to additional activities needed to set up the implementation part. *Among the findings, it stands out that nearly half of the impact factors identified are predetermining the pathway while the other half includes impact factors caused by events emerging during the research, development* and exploitation process and are influencing the pathway largely – depending on the participants´ behaviour.

In sum, not only do specific impact factors influence the type of pathway towards the market-oriented exploitation but there are impact factors that predetermine the pathway and there are impact factors that are influencing the pathway. Based on the type of technology explored or research being conducted the successful pathways to market-oriented exploitation differ, e.g. developing a completely new type of material creates a completely different path to success than improving on an existing production process through new algorithms etc. The more basic the research (e.g. nanotechnologies in contrast to production process technologies) the more radical an innovation produced, extending the time-to-market and increasing the need for additional efforts such as further research. *Success depends strongly on how many and what types of events – that cause need for change or adaption – emerge during the project and how organisations and individuals manage them and the respective challenges.*

Conclusions

→ the market-oriented exploitation of research outcome is most notable challenged by finding avant-garde customers or the so-called commercial 'valley of death'

→ success in market-oriented exploitation depends strongly on how many and what types of events – that cause need for change or adaption – emerge during the project and how organisations and individuals manage them and the respective challenges

→ although the most effective impact factors occur in later stages of the innovation and market-oriented exploitation cycle, most of the crucial decisions – including mistakes – are made in the earlier stages

Good practice in knowledge transfer and market oriented exploitation

The aim of this part of the study is to investigate public and private good practice approaches to the intricate issue of how to optimally support the bringing of novel ideas from research to the market place. A distinction can be made between time limited funding programmes and the permanent structures that undertake the specific activities of transferring technology.

Support for early stage, upstream activities are characterised by knowledge-intensive activities in close proximity to the producers of new technologies, with the funding organisation – either itself or by way of agents – typically being intimately involved in the knowledge-intensive process to underpin the commercialisation. Moreover, the operating funds are substantially smaller than is normally associated with venture capital and subsequent funding stages further downstream, which is in accordance with the higher risk taken by the investors in the technology transfer segment, even in comparison with venture capital.

The support instruments relevant to this discussion mainly focus on bringing technologies from universities and public research centres to the market, and this can be done in two ways; either the technology is licensed out or a spinout company is created to back its further development. A range of organisations of different types supports technology transfer, and the segment is characterised by public private partnerships.

1.12. Public policies

While direct support for commercialising research results may not traditionally have been part of the instrumental repertoire of public authorities, the tendency to identify, develop and implement such mechanisms has been steadily increasing in the past years. The increased awareness and attention to the market-oriented exploitation of research results at the policy level follows the overall trend of public sector attempts to support job creation and economic growth, and this development is parallel and in part related to the decrease in the availability and return-on-investment associated with venture capital. While ultimately substantial parts of funds to create schemes in support of commercially exploiting research results derive from public authorities, university technology transfer offices, foundations, and private companies most often undertake the specific actions involved in technology transfer.

1.12.1. Scottish Enterprise Proof of Concept Programme, UK

Main characteristics

The Proof of Concept (PoCP) programme supports the pre-commercialisation of innovative technologies emerging from Scotland’s universities, research institutes and National Health Service Boards. It aims at helping researchers transfer their ideas and inventions from the laboratory and onto the international market. Projects are typically defined as being at the stage after advances have been made during both curiosity-driven (‘blue sky’) and strategic research. The programme finances only projects with strong commercialisation potential, and does therefore not constitute an additional source of research funding. A comprehensive list of technologies and their projected destiny (license or spin-out company) – along with their status – can be found on the web.[4]

The PoCP is thus an initiative that supports the essential transition from initial research results to first prototype for researchers in Scotland. Since its start in 1999 the programme has supported 201 projects through public funding amounting to £36.4m, and 153 of those were completed by the autumn of 2007. 38 spinout companies have been created and 35 licensing deals have been concluded, leading to the creation of over 500 jobs; this is an outstanding outcome, particularly in the light of the high-risk nature of the projects. The programme has furthermore given rise to a subsequent £207m of public and private investment, which would not otherwise have taken place. Fewer than 20% of the projects have failed due to technical reasons, a share that would be acceptable given the exploratory nature of the projects attempting to transform research results into marketable products.

Even though Scottish Enterprise runs the programme there is a strong emphasis on maintaining a wide-ranging programme partnership. Scottish Enterprise has set up a stakeholder panel that annually evaluates programme outcomes and effects from a strategic standpoint. On their part, Scottish universities have established a PoCP working group that cooperates with the Scottish Enterprise management team to present views on relevant matters that emerge within the universities. Moreover, it has been an essential part of the programme management activities to raise awareness and to put forward the PoCP activities with regards to the extended partnership and other stakeholders in Scotland as well as overseas.

The programme has also been observed to have a constructive bearing on the Scottish innovation system, which is an interesting hint at impact at a more strategic level. The 2006 evaluation concluded that the PoCP brand and the quality of the programme's projects made them eligible for both public and private funding at an earlier stage than they otherwise would have been. In addition it was possible to make out shifts in institutional cultures, above all with regards to academic research institutions and the National Health Services Boards, in which the commercialization of research results is now considered as a gratifying pursuit.

Main objectives and support mechanisms

The overriding purpose of the PoCP is to generate new high-growth companies based in Scotland, with the prospective and aptitude to achieve significant growth. 'Significant growth' is defined as the reaching at least a £5 million turnover within 5 years of trading or the raising of at least £10 million non-public investment within the same time period, and which can subsequently continue to growth. The programme focuses on financing projects with strong potential for commercialisation.

Most of the projects funded by the programme logically hold a high degree of risk, and this risk certainly also relates to the commercial potential of ground breaking technologies. As part of the strategy to fund the projects, significant resources – both with regards finance and personnel – are dispensed to reach the projects' potential. After an idea for commercialisation has been identified, an assessment of its feasibility is required. This assessment is of crucial importance in order to decide whether to continue

[4] http://www.scottish-enterprise.com/start-your-business/proof-of-concept-programme/proof-of-concept-projects.aspx

with the project by licensing the intellectual property or to establish a spinout company; or whether to abandon the effort of commercialisation altogether due to an inadequate market pull or technological feasibility. Importantly, the costs of patenting are borne by the programme.

Lessons learned

An essential part of the success of the PoCP has been the existence of the much specialised management team, with its adaptable approach to programme execution over an extended period of time. The position of the management team within an established agency for the promotion and support of enterprises, with all that entails in form of financial and personnel resources, expertise, and networks both regionally, nationally, and abroad. The continuous strategic view of project outcomes and the adjustments to the programme emanating from this process has also been part of its success.

A leading principle of the programme execution has been a strong focus on sustaining researchers in relation to the commercial phases of their projects. The PoCP funding has been an important catalyst to free up time, enabling academic researchers to focus on commercially developing their projects, which otherwise would have been spent teaching or carrying out, e.g., administrative duties.

The attention to the business aspects of developing research results towards the market has also been coupled with a comprehensive understanding of the motives for academic researchers to involve themselves in commercialisation. The work of Scottish Enterprise industry specialists and advisors, and subsequently the ’outcome managers’ have, furthermore, helped forging indispensable links for the projects to industry and financial players. Also, there has been crucial awareness within the framework concerning the fact that researchers themselves may not always be the ideal people to advance the established spinout company, and thus the project management group or the outcome manager has been instrumental in involving relevant CEOs or other non-technical personnel.

A stakeholders group supplies strategic advice to the programme managers. PoCP projects have, thus, profited from access to knowledge and know-how as a result of Scottish Enterprise’s close association with the universities’ commercialisation offices as well as with industrial sectors of priority and the financial realm.

This intimate association to expertise and know-how does not have regional or national boundaries; Scottish Enterprise has instead rather effectively strived to link projects into international networks of business and industry. The PoCP has furthermore proven to be geographically transferable, above all to countries with excellent academic research activities coupled with a less developed frameworks for commercialisation.

The PoCP is a strategic programme situated in a framework of support instruments. The European Regional Development Fund has provided additional funding to further develop the concept, which has given programme managers the opportunity of trying out novel functions, especially the ‘outcome managers’, and to additionally finance previously funded projects the last bit to the market or to substantial private investments. PoCP is one essential link in a chain of support processes, which allows commercialisation projects from academia to obtain additional support in order to advance commercial development. Access to seed and venture funding for projects, including the ERDF co-financed Scottish co-Investment Fund, has been a crucial success factor. A free-standing

PoC programme has much smaller chances of having an impact, or even of being capable of delivering high-growth companies for the benefit of economic growth in society.

1.12.2. VALIDATION OF THE INNOVATIVE POTENTIAL OF SCIENTIFIC RESEARCH (VIP), GERMANY

Main characteristics

The German VIP (validation of the innovative potential of scientific research) programme is a public support programme launched in 2010 that aims for supporting proof of concept/technology and other feasibility analyses investigating the economic potential of a technology. The support is thematically open to all projects in the so-called orientation stage of the innovation process; the stage that includes the proof of feasibility, proof of marketability and investigation of fields of application. The programme invites scientists to check their research results with respect to their economic value and economic use. The project is designed for universities and research institutions (including Fraunhofer and Max Planck among others) completely or partially financed by the German federal government and/or the German federal states.

The programme is part of the German federal 'high-tech strategy' that was introduced in 2006 as a means to a more coordinated innovation policy by bundling public support provided by different federal ministries into a coherent and joint attempt to strengthen and improve Germany's innovation output. The programme is owned by the Federal Ministry for Education and Research and managed by Project Management Jülich.

Streamlined with the 'high-tech strategy', the VIP programme is aiming for an increase in motivation of researchers in universities and public research organisations to test their research results for economic usability and to actively participate in all activities necessary for the transfer of research results into marketable products, services etc.

Main objectives and support mechanisms

VIP is supporting projects (currently 50) in the area of problem-oriented basic research resulting from publicly funded research. It explicitly addresses the often missing link between basic research and marketable innovations by enabling researchers in more basic research – who are not already cooperating with companies due to the basic nature of their research – to proof both feasibility and economic value of their research outcome. To this end, the programme is closing an existing funding gap between basic funding for universities and other research organisations and funding for collaborative research in research-industry cooperation. While it is considered very important and successful, the programme does not accept any more applications since July 2012.

VIP provided funding on a project-basis over a 3-year period amounting up to a maximum of € 500,000 annually, i.e. not more than € 1.5 million in total. The research – although it might already have patented – had to be at a stage where there were neither licensing activities, industry cooperation nor plans for spin-offs. At this stage private companies are generally not willing to invest due to the research's inherent high risk to still prove not feasible or the fact that the research outcome enables completely new applications. Every project was obliged to include an 'innovation mentor' whose main task is to safeguard that every transformation step is aligned to the requirements of innovation processes and to link the project to additional external expertise. In order to ensure the continuation of the development beyond the duration of the project, the knowledge transfer institutions already in place at the research organisations were included in the projects. The projects' market-oriented exploitation pathways were not limited to any specific type of commercialisation. Project proposals had to include a commercialisation and an intellectual property (including links to existing IPR) strategy.

Lessons learned

In 2006, the German RDTI policies changed significantly with the publication of the federal 'High-tech Strategy' by introducing more cooperation among policy makers from different policies, further strengthening research-industry links and closing funding gaps. However, only with the VIP programme the federal government managed to successfully link basic research to the performance of the innovation system. It acknowledges not only the fundamental importance of basic research as the foundation for applied research (and thus, innovation) but the fact that whenever basic research becomes problem-oriented it can produce research outcomes that already have an economic potential. Thus, for the first time public support is available in Germany that directly unlocks basic research for commercial applications.

In addition, the programme is not only closing a crucial funding gap by providing financial support to link basic research to private companies but introduces a policy innovation by deviating from the common approach to use 'traditional' research cooperation as a means to tap the full economic potential of research outcomes.

However, the arguably most interesting approach is to oblige the project to include external expertise via a mentoring system. The 'innovation mentors' do not only serve as advisors to researchers who do not necessarily possess the knowledge needed for the transformation of research outcome to innovations but by providing links to even more external expertise help to prevent the application focus from becoming too narrow.

1.12.3. Canadian Innovation Commercialization Program, Canada

Main characteristics

The Canadian Innovation Commercialization Program (CICP) was created as part of the Canadian government's Budget 2010 document, a strategy targeting the creation of jobs and growth for 'the economy of tomorrow' by providing support programmes and other policy initiatives. CICP was explicitly designed to bridge the gap between successfully completed R&D projects and their market-oriented exploitation (i.e. innovative products and services) by creating opportunities for companies to their innovations assessed with regard to performance, quality etc. and by adding a possibility to move innovations from laboratories and demonstrations to commercialisation with the help of public procurement. Thus, it completes the already existing support system of funding research and innovation projects. It targets innovations in four priority areas:

- Environment (e.g. waste management, renewable/alternative energy, energy efficiency)
- Safety and security (e.g. surveillance, military engineering, sensor technology)
- Health (e.g. public health, medical devices, consumer safety)
- Enabling technologies (e.g. ICT, nano- and biotechnologies)

CICP is managed by Public Works and Government Services Canada (PWGSC), and implemented by the Office of Small and Medium Enterprises (OSME).

Main objectives and support mechanisms

The programme application procedures are based on calls for proposal for specific priority areas and selection criteria that change with the priority area addressed. Next to financial support, the programme offers the participation in regional events and trade shows to showcase the innovations developed to public procurement organisations. Thereby, the programme utilises two major effects of public procurement of innovations: (1) the public administration acts as a test user validating the innovations' performance and thus, it can create an impulse of authentication or reassurance for other potential customers not able or willing to take the avant-garde's or early adopters' higher risks, and (2) public procurement simply creates return-on-investment and thus, a source of income that helps companies to bridge the commercial 'valley of death' between small-scale sales in the earliest stages of commercialisation and mass production in later stages. As a side effect, public administration improves its performance, efficiency, sustainability etc. by using a more advanced technology, product or service.

By focussing on public procurement, the programme is offering four different, complementary support activities:

- Awarding contracts to entrepreneurs with pre-commercial innovations
- Testing and providing feedback on the performance of innovations
- Providing innovators with the opportunity to enter the marketplace via public procurement
- Providing information on how to do business with public administrations

Eligible innovations must have a Technology Readiness Level score that is between 7 and 9 (from system prototype demonstration in an operational environment to actual technology proven through successful deployment in an operational setting). Any organisation, university, private company, not-for-profit organisation or individual can submit a proposal.

CICP uses a competitive approach: following the proposal evaluation process, only the top ranked proposals will be forwarded to a pool of pre-qualified proposals based on the available budget. Proposals selected are matched with a testing department (departments and agencies that either act as public procurers themselves or as validation authorities to other procuring organisations) based on the testing departments' ability and agreement to perform the assessment. The testing department evaluates the innovation being proposed. However, this also means that pre-qualified innovations are not guaranteed a contract until a mutual agreement between the supplier and the public administration has been achieved on all terms and conditions of any resulting procurement contract.

Three major success stories supported through CICP include:

- 3DPartFinder™ (http://www.3dpartfinder.com/en/Home.aspx; 3DSemantix), a search engine that does for parts what Google does with text,
- the Radiation-Detecting Speedbump (http://www.bubbletech.ca/; Bubble Technology Industries Inc.), a radiation detector concealed inside a speedbump to sense the presence of illicit radioactive materials, and
- JACO (http://kinovarobotics.com/; Kinova), a six-axis robotic manipulator arm with a three-fingered hand controlled by various interfaces.

Lessons learned

The potential effect of public procurement on commercialisation of innovations has been described and discussed in many studies, workshops etc. and the European Commission organised high level groups, made public procurement an element of its Lead Market initiative etc. However, the actual implementation of respective policies is still lagging behind in most European countries despite the wide-spread and perpetual praise for the US-American SBIR programme that also includes procurement as a means to fostering innovations. With its CICP programme the Canadian government implemented an exemplary approach to the utilisation of procurement budgets for the support of innovations.

What makes CICP an example of good practice is also the fact that it is not exclusively targeting private companies, although they naturally form the majority of organisations benefitting from it. Not only does CICP acknowledge the relevance of research conducted in universities or private sector research organisations for marketable innovations, it also enables these organisations to act without having to seek industrial partners and thus, comprising their idea of potential applications provided that they have the capacity to develop their research outcome up to the required TRL level 7-9.

1.12.4. Technology Enterprise Commercialisation Scheme, Singapore

Main characteristics

The Technology Enterprise Commercialisation Scheme (TECS) is an R&D grant for the commercialisation of a technology idea which involves significant R&D in a specific science or technology area or leads to the development of a technology IP.

TECS is managed by SPRING Singapore, an enterprise development agency under the Ministry of Trade and Industry who works with partners to assist enterprises in financing, capability and management development, technology and innovation, and access to markets.

Main objectives and support mechanisms

Through the scheme, aiming at the development and growth of start-ups based on strong technology Intellectual Property and a scalable business model, SPRING provides early-stage funding for successful applicants. Funding subject is their R&D effort (of entirely new, innovative and potentially market-changing technology IP) towards the commercialisation of proprietary technology ideas.

The TECS is a competitive grant in which proposals are ranked based on the evaluation of both technical and commercial values by a team of reviewers. Submissions can be made throughout the year. Proposals are reviewed every two months or earlier. Projects must meet following evaluation criteria:

- a demonstration of how science/technology is applied;
- indication of a breakthrough level of innovation which either has the potential to disrupt an existing market or to replace, or even create, a new market/purpose/niche.
- high level of riskiness and further away from the market
- lead to or build on proprietary know-how / IP

- be commercially viable

The evaluation process is divided into three stages of selection: eligibility screening - focus on technical and commercial aspects – presentation to the panel. TECS consists of *two project types* eligible to be funded:

- Proof-Of-Concept-projects (POC): an idea is at the conceptualisation stage and the technical/scientific viability of an idea needs to be proven. Proof-Of-Concept-projects are supported with up to 100% of the costs
- Proof-Of-Value projects (POV): a proof-of-concept is available already and a need for carrying out further R&D or develop a working prototype is identified, to validate the commercial value of an established concept. It is also required to demonstrate proof-of-interest from a potential customer or 3rd party investor, and the necessary business competencies to implement the project. Proof-Of-Value projects are supported with up to 85% of the costs.

Start-ups are allowed to apply for both project types, while researchers can apply for Proof-Of-Concept-projects only. Costs that can be covered are manpower-related costs, professional services (i.e. consultancy, sub-contracting), equipment, software, IP Rights, materials, and other operating expenditures (i.e. training intrinsic to the project)

<u>Lessons learned</u>

The TECS is a competitive grant to support two types of undertakings crucial for successful commercialisation: Proof-Of-Concept-projects and Proof-Of-Value projects.

The Scheme stands out due to its intentional high selectivity. Each project proposal has to pass a three-stage evaluation process with stringent evaluation criteria. It clearly aims at projects with a breakthrough character and disruptive impacts. In 'return' the funding rates are rather high.

In addition the TECS is clearly dedicated to the Singapore area; funded projects must show an utmost importance and benefit to be expected for the area itself. For this reason the TECS demands projects within predefined thematic areas (i.e Biomedical Sciences), strategically important for Singapore.

1.12.5. Commercialisation Australia, Australia

<u>Main characteristics</u>

Commercialisation Australia is an assistance programme carried out by the Australian Government that provides an integrated approach to help take products, processes and services to market. It offers a range of tailored assistance measures for specialist advice and services, proof of concept and early stage commercialisation activities. As at 25 February 2013 Commercialisation Australia had announced support for 375 Participants with grants valued at $147.8 million. Specific program components include

- Skills and Knowledge support to help build the skills, knowledge and connections required to commercialise intellectual property
- Experienced Executives
- Proof of Concept grants
- Early Stage Commercialisation grants

Each participant is assigned a 'Case Manager' who guides participants through the commercialisation process and facilitates their access to experienced 'Volunteer Business Mentors'.

Main objectives and support mechanisms

The main objective of the programme Commercialisation Australia is to bring the participants in the position to independently engage in the marketplace - raising money from the private sector, licensing their technology, entering joint ventures, or simply trading profitably. Specific Funding Schemes of Commercialisation Australia are:

- Skills and Knowledge support provides participants with access to expert advice and services to build the required skills, knowledge and linkages. This support is aimed at assisting people new to commercialisation - whose products, processes or services have commercial potential. (80% of costs are funded). Among the activities funded are business planning (i.e. risk analysis), market research, IP management, capital raising, etc.
- Experienced Executives provides participants with the opportunity to employ an experienced Chief Executive Officer and/or other senior executive talent with the right skills to successfully take a new product, process or service to market. (50% of costs are funded).
- Proof of Concept grants fund the steps necessary to establish the commercial viability of a new product, process or service. (50% of costs are funded).
- Early Stage Commercialisation grants provide funding for the steps necessary to bring a new product, process or service to market. This support is aimed at companies who have an innovative product with potential but need assistance in areas such as, but not limited to, development, market validation, compliance with industry standards, and early sales. (50% of costs are funded).

Complementary to the specific programme components each participant is assigned a *'Case Manager'* who guides them through the commercialisation process and facilitates their access to experienced '*Volunteer Business Mentors*'.

Case Managers are partnered with participants for the duration of their involvement with the programme and guide them through the commercialisation process. Case Managers have extensive experience in commercialisation; many of them have taken their own products and services to market, and have good access to industry networks. They provide assistance by:

- assisting participants to identify the skills and knowledge they need;
- helping them access specialist advice and service;
- identifying and linking them with appropriate Volunteer Business Mentors;
- assisting them develop professional networks;
- providing strategic and operational advice; and
- monitoring their progress.

Volunteer Business Mentors are another key element of the tailored assistance of the programme. They are an additional resource to further assist the participants in approaching and establishing business contacts necessary to develop their intellectual property (IP). Commercialisation Australia has available a diverse range of Volunteer Business Mentors with hands-on experience in building and/or selling a business, specialist domain expertise, knowledge of international markets and extensive networks in their areas of expertise.

Lessons learned

Commercialisation Australia is an initiative of the Australian Government. The programme offers funding and resources to speed up the business building process for Australian companies, entrepreneurs, researchers and inventors looking to commercialise innovative intellectual property. It combines a well-matched range of funding options and in addition networking opportunities to support to achieve business success. Complementary to the support schemes the individual guidance by experienced mentors ('Case Managers') shall safeguard a smooth road to success.

The programme also stands out with its open and flexible procedures. Participants can access the programme through any one of the components, and exit at any point. Multiple forms of assistance may be accessed concurrently or consecutively, based on the needs of the applicant.

Commercialisation Australia explicitly acknowledges the high risk nature of the projects it supports and takes into account their potential failure. The programme clearly encourages voluntary terminations ('fast failures') and assesses such terminations as a positive indicator of the management team's capability in any future application for funding under the programme. With this explicit acknowledgement the programme is an exception rather than a rule.

1.13. TECHNOLOGY TRANSFER ORGANISATIONS

In contrast to the aforementioned public actions in support of research commercialisation, which are enabled by policy-level financial commitment, fully dedicated permanent organisations are also active in the technology transfer segment. While their common goal is to bring research results to the market place, their ownership and reasons for establishment vary. They may consist of technology transfer offices that are part of the university, or separate entities in the form of non-profit foundations or companies created with the purpose of transferring technology. Another entity category is companies that have as purpose to transfer technology with the aim of maximizing profit.

1.13.1. KU LEUVEN[5]

Main characteristics

KU Leuven has an intricate innovation system that involves the university leadership, researchers, the technology transfer office, and access to capital for technology transfer by spinout creation. KU Leuven Research & Development (LRD) is the technology transfer office of the so-called KU Leuven Association. Since its inception as one of Europe's first TTOs in 1972, a multidisciplinary team of experts has guided researchers in their

[5] Presentation by Professor André Oosterlinck, Materials Research Society Fall Meeting 2012, Boston; lrd.kuleuven.be/en/index

interaction with industry and society, and helping them validate their research results. The university participates in a range of networking activities to develop technological clustering, entrepreneurship and innovation at the regional level.

The creation of spin-off companies has over the years become an important mechanism for the transfer of university research results, and LRD has a long had tradition for supporting the creation of such companies. Over the past three decades this has led to the creation of nearly a hundred spin-off companies (November 2012), directly employing more than 3,500 people in the Leuven region only. The revenue generated from licensing agreements amounts to about 60 million euro annually.

<u>Main objectives and support mechanisms</u>

The main objectives of the LRD technology transfer office has, since its creation in the early 70’s, been to increase innovation by way of a wide variety of interactions and mechanisms with relevant parties.

LRD is a separate entity within the university that seeks to endorse the transfer of knowledge and technology between the university and industry and society. The unit provides advice about legal, technical as well as business-related issues. The first relevant area of activities include the management of and advice on research collaborations, which includes assessments determining opportunities for innovation and technology brokerage initiatives, as well as to negotiate conditions of research agreements, including, e.g., work plan, pricing, intellectual property rights, and so forth. Another second important area of activities is the management of intellectual property rights; an active patent and licensing policy is pursued with respect to the university’s research results, allowing LRD to generate funds for further scientific research.

Support is also offered relating to the creation of new research-oriented and innovative spin-off companies, enabled by professional advice and access to capital, and accommodation in the incubators and in science parks for entrepreneurs who want to set up a business that makes use of the university's knowledge or technology.

A mechanism for decision making and incentivising has – quite extraordinarily within the context of a university – been implemented within the university structure. Researchers can form dedicated LRD research divisions, through which they can manage their technology transfer activities autonomously but with support from LRD, and drive innovation and entrepreneurship in combination with high-level research and education. Such LRD research divisions have been observed to stimulate interdisciplinary collaborations by allowing researchers to cooperate across the boundaries of departments and faculties.

<u>Lessons learned</u>

The case of LRD clearly shows that successful university technology transfer is dependent upon being a central and evident part of the university’s mission, that is, there must be a clear commitment to commercialisation as a prioritised area of activity from the highest ranks of the university management. Along the lines of this rationale the technology transfer office (TTO) must, therefore, have a direct link with the university president or vice president. Explicit and clear responsibilities and mandate of the TTO are also essential.

Technology transfer at university level is not a spontaneous process; it needs to take the form of a closely coordinated interplay between researchers, technology transfer personnel and external partners. A well-placed TTO thus plays a vital role in the innovation and commercialisation ecosystem of the university. In addition, a critical mass of high quality research must exist for successful technology transfer, as a certain flow of protectable ideas that can be turned into high-quality intellectual property must emanate from this research. The knowledge and hands-on experience of technology transfer personnel is a determining factor for success, and here experience and expertise relating to the technical, commercial, and legal aspects of intellectual property and its role in innovation are essential parts. Additionally, a clear decision-making process and incentive structure are essential to entice researchers and research groups to commit to commercialising their research results.

Experience shows that experienced technology transfer personnel should be involved already at the research stage, in order to enable the assessment of commercialisation possibilities. This is done to ensure that business opportunities are not lost due to untimely publication of research results, to help directing relevant research towards solving an existing industrial problem, and to assist in attracting funds for essential non-research activities.

1.13.2. INDEPENDENT COMMERCIALISATION COMPANIES[6]

Main characteristics

Private enterprises with the intention to maximize profit are also active within the technology transfer segment. In the UK, IP Group and Fusion IP are two prominent examples of publicly traded companies. These intellectual property commercialization companies focus on developing technology-driven innovations emanating mainly from its research-intensive partner universities. The approach of these holding companies diverges from that of traditional venture capital actors, in that they provide their portfolio companies with access not only to capital but also to expertise relating to business building, networks, recruitment and business support.

IP Group was founded in 2001, listed on the AIM (formerly called the Alternative Investment Market)[7] of the London Stock Exchange in 2003, and then moved to the Official List in June 2006. The Group now has long-standing partnerships with ten universities in the UK, and further has indirect access to intellectual property under to an additional two under its commercialization agreement with Fusion IP. IP Group's portfolio includes holdings in over 60 companies, including Oxford Nanopore Technologies, a DNA sequencing development company, Revolymer, best known for its removable chewing gum and Xeros, which has received attention for its novel clothes washing techniques that involves greatly reduced water consumption. The portfolio spans early stage to mature businesses and is exposed to five main sectors – energy and renewables, medical devices, medicine/biotech, ICT and chemicals/materials. To date, fourteen of the portfolio companies IP Group has supported have listed on the AIM market of the London Stock Exchange and one on PLUS Markets.

[6] www.ipgroupplc.com; www.fusionip.co.uk; information from respondents.

[7] The AIM is a sub-market of the London Stock Exchange (LSE), which allows smaller companies to float shares based on a more flexible regulatory system than the main market. The AIM is thus characterized by a flexibility that is provided by less regulation and no particular requirements for capitalization or number of issued shares.

Moreover, IP Group has a co-investment agreement with Fusion IP, through which IP Group has the right to acquire 20% of Fusion's equity in any new portfolio company. Fusion normally owns 60% of any new portfolio company at start-up, which means that IP Group's shareholding normally equates to a 12% stake in the new portfolio company. Fusion IP was established in 2002 to commercialize university-generated intellectual property. It has long-term agreements with two of UK's leading research-intensive universities, the University of Sheffield and Cardiff University, giving it exclusive access to all the IP created by their research departments. These agreements enable Fusion IP to identify high quality intellectual property and turn it into commercial opportunities, either through the creation of start-up companies or by way of licenses.

The company currently owns shareholdings in more than 20 portfolio companies, including significant shareholdings in Seren, Magnomatics, Phase Focus, MedaPhor, Asalus and Diurnal. Fusion IP announced its first major exit in February 2012, with the sale of its portfolio company Simcyp, a company that has developed a modelling and simulation platform for predicting the effect of drugs in virtual populations, to US-based Certara for $32m – corresponding to a 200-fold return on its original investment.

<u>Main objectives and support mechanisms</u>

The primary objectives of the publicly traded commercialization companies is to create value by turning intellectual property into commercial opportunities, while meeting the expectations of both institutional and non-institutional shareholders. They operate a model which is quite different from the approach more conventional investors, in that business building is carried out in closer collaboration with company founders and team than is normally the case for the typical venture capitalists. The independent commercialisation companies have developed methods to systematically commercialise intellectual property, which includes three main components; securing a deal flow, building business concepts, and providing capital.

A deal flow is generated through building exclusive, long-term relations with UK universities. IP Group currently has access to the IP of twelve of the country’s leading universities, together with an additional two provided through the agreement with Fusion IP. The company’s sourcing team works with partners to identify promising research and to create and build business concepts around such cases. Hypotheses-based methodologies are employed to assess new opportunities and decide which to advance further. These techniques are also used to monitor progress and shape the evolving strategy.

During the early development stages of a commercialisation opportunity, the in-house team works directly with founders to form its strategic direction and often also assume a temporary commercial management role until the business reaches an adequate point of development to extend the management team. Experienced management team with extensive contacts in industry, government, academia and finance together with strong in-house expertise in life and physical sciences and in building high growth businesses.

Capital flows to portfolio companies from the main company, but funds can also in part originate from venture capital funds. Moreover, there are close ties with networks of co-investors, who can thus provide additional further capital along the route financial route.

The exclusive partnership agreements with the universities provide up to 100% of their future IP and the right to up to 100% of the equity in the generated spinout companies on incorporation. Subsequently giving academics a significant shareholding in the spinout company aligns their interests with commercialisation.

Lessons learned

In comparison with companies owned by the universities themselves – which are founded with the purpose of successfully transferring knowledge from that very university to the market – independent versions aim to maximize profit, and are as such to a higher degree subject to market conditions.

Like companies set up in conjunction with a single university to commercialise its technologies, freestanding ones also focus intensely on exploitable intellectual property as the very foundation upon which to build their portfolio companies and drive the commercialisation process. Sealing exclusive agreements with multiple universities provides necessary pipelines of exploitable intellectual property, which in turn also ensures deal flows. The combination of access to exploitable intellectual property, in-house and sourced commercial and industrial expertise, along with start-up funding, enables the transformation of high-grade academic research results into businesses.

Capitalisation of the publicly traded companies has been achieved by floating shares on the stock market, which means they have not, unlike commercialisation companies set up by universities, enjoyed public support.

European level support for technology transfer

As noted in previous sections of this chapter, a diversity of entity types directly act in the technology transfer arena, such as university technology transfer offices, private companies set up by universities to perform their TTO activities, as well as free standing commercialisation companies that may have been floated on the stock market to achieve capitalisation. Regions and nations have also set up network-based market-oriented exploitation initiatives with varying results, spanning from success to failure.

Although market-oriented exploitation certainly is an international endeavour, the described initiatives and organisations focus on performing activities and follow opportunities on the local, regional and national level, as that is where research results and the associated intellectual property are produced. As players on these political levels, at the time of their inception (and sometimes subsequently) they first and foremost received external capital as a result to decisions by political organisations or private organisations at either of these levels.

Along with the visibility of successful practises and support mechanisms to transfer technology, it is possible to discern an increasing tendency of European level public support for such activities through both actions and funding instruments. Thus, while not representing technology transfer good practise themselves, these support actions aim to strengthen commercialisation of European research results at the local, regional, and national levels. They will be accounted for here as they indicate the growing focus on technology transfer from the supranational European standpoint, but as a function of the more extensive time frame associated with commercialisation of research results, the impact of these specific measures remain to be assessed.

1.13.3. European Investment Fund

The European Investment Fund (EIF) is the European Investment Bank (EIB) Group's dedicated supplier of risk finance for small and medium-sized enterprises (SME) across Europe. Owners include the European Investment Bank (EIB), the European Commission and a range of public and private banks and financial institutions. The EIB works as a public-private partnership and benefits from the Multilateral Development Bank status, which enables financial institutions to apply a 0% risk weighting to assets guaranteed.

One of EIF's investment strategies is to provide risk finance by way of its so-called 'technology transfer' equity product. EIF is one of Europe's largest and most active investor in the field of technology transfer, providing both guidance and cornerstone financing. Being one of its strategic areas, technology transfer is defined as the process of transforming the results of research and development into marketable products and services. The EIF notes that support to technology transfer must occur through a more active commercialisation of intellectual property, and that IP management has to be integrated in such strategies from the outset, as IP is a major instrument for transferring knowledge and for generating revenue.[8]

The EIF works a model that aims at identifying and supporting sustainable technology transfer structures in Europe, which could then be viewed as development of financial good practice. The targeted intermediaries normally invest into projects or start-up companies, at proof of concept, pre-seed, seed, post-seed to A & B rounds, after which stages conventional venture capital or private equity investors can finance the companies further. The EIF thus provides an instrument enabling support from the European level to be given at the regional, where innovation actually takes place.

Interested intermediary structures go through a due diligence process, and have to meet a range of requirements, which can be summarised under the following criteria:

- Management team
- Investment strategy
- Track record
- Target market
- Deal flow
- Geographical scope
- Target sectors
- Fund size
- Legal structure
- Proposed terms
- Expected returns
- Eventual participation of other investors
- Timing of fund raising

The EIF has to date invested in IP Group, UK (31 M£), Chalmers Innovation, Sweden (9.5 M€), KU Leuven/CD3, Belgium (24 M€), UMIP Premier Fund, UK (32 M£) and Karolinska Development, Sweden (26.7 M€). It is expected that the number of qualified and interested intermediary structures will increase along with the growth of the technology transfer segment. Return on Investment is not foreseen within the time frame of more conventional risk capital investment funds, that is, about 10-15 years, but rather after a

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[8] http://www.eif.org/news_centre/publications/eif_wp_2009_002_financing-tt_fv.pdf

time period of up to 25 years. It is also foreseen that the effect of actions supporting the financially more upstream activities associated with technology transfer will thus help countering the so-called European Paradox, the perceived European inability to transform high-quality research into business.

1.13.4. European Regional Development Fund[9]

While the EIF's approach is to boost technology transfer directly by co-investing with intermediaries with good track records, the underlying rationale for ERDF to support this market segment is connected with its aim to strengthen economic and social cohesion in the European Union, by correcting imbalances between its regions. To do this the ERDF finances direct aid to investments in companies – in particular SMEs – to create sustainable jobs, infrastructures linked particularly to research and innovation, telecommunications, environment, energy and transport, financial instruments (capital risk funds, local development funds, etceteras) to support regional and local development, as well as to foster cooperation between towns and regions, and also developing technical assistance measures.

The ERDF can intervene in the following three objectives of regional policy: 1, Convergence, 2, Regional Competitiveness and Employment, and 3, European Territorial Cooperation. Of these three, it is the 'Regional Competitiveness and Employment' objective that is the most relevant for technology transfer, with particular reference to the first of its three priorities, 'Innovation and Knowledge-Based Economy'. The ERDF interventions in this area aim at strengthening regional capacities for research and technological development, at promoting innovation and entrepreneurship, and at reinforcing financial engineering especially for companies involved in knowledge-based economy.

A large number of projects and organisations involved in technology transfer have been funded through a range of different instruments, perhaps the most notable of those in terms of technology transfer good practise is follow-up funding of the aforementioned already successful Scottish Enterprise POCP programme. Other actions include the creation of co-financed risk capital investment funds, such as the different funds set up across European member states to be active between 2009 and 2014. The funds must operate according to a certain set of rules:[10]

- The funds shall supplement the market and work on commercial terms
- The funds are public venture capitalists that shall normally make equity capital investments of around 100 000 - 1 million euro directly in SMEs in the start-up and expansion phases
- The funds are co-investment funds and shall invest with independent private commercial actors on equal terms
- The funds can only invest in their own respective regions
- The funds aim to be revolving – returns shall be reinvested in the region
- The management fee shall not exceed 3% of the fund's capital base

The potential impact on technology transfer exercised by these funds in different member state regions remains to be measured through different evaluation measures. Future evaluations will have to answer the following two fundamental questions:

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[9] http://ec.europa.eu/regional_policy/thefunds/regional/index_en.cfm
[10] http://www.circle.lu.se/upload/CIRCLE/reportseries/201205_Avdeitchikova_Brulin_Jonung_Rydell.pdf

- Can these funds function as effective venture capitalists given their task, structure and regional conditions?
- Can this fund type – through the investment actions of the capital management intermediary – provide the results and effects in society expected by the EU and the respective member state government?

1.13.5. EUROPEAN RESEARCH COUNCIL PROOF OF CONCEPT[11]

The European Research Council's (ERC) mission is to advance the highest quality research in Europe through competitive funding, to support investigator-initiated frontier research[12] across all fields of research based on scientific excellence. The ERC grants are expected to underpin the creation of new and unpredictable scientific and technological discoveries of the kind that can constitute the basis of new industries, markets, and broader social innovations of the future.

Based on the rationale that groundbreaking innovations spring from frontier research, the ERC initiated a Proof of Concept scheme in March 2011, from which funding is made available only to those who already enjoy an ERC research award, to establish proof of concept of an idea that was generated in the course of their ERC-funded projects. The funding available for each project is up to 150.000€, for a duration of 12 months.

The activities to be funded are aimed to draw on the outputs of ERC-sponsored research, but are not for the extension of original research activities. The PoC funding aims at supporting grant-holders during the pre-demonstration stage to prepare a concept to be presented to venture capitalists or companies, who might invest in the new technology and take it through the early commercialisation phase.

The PoC projects to be funded will have arisen from scientifically excellent ERC-funded research that has already been subject to meticulous peer review. The PoC proposals will thus be evaluated on the basis of the following three evaluation criteria:

- Innovation potential: There must be strong arguments indicating that the proposed Proof of Concept activity could greatly help move the research result towards the initial steps of pre-commercialisation efforts
- Quality of the PoC plan: The proposed Proof of Concept is based on a sound approach for establishing technical and commercial feasibility of the project
- Budget: The requested budget shall be necessary for the implementation of the proposed Proof of Concept and properly justified.

The ERC PoC financing can be used to:

- Establish viability, technical issues, and overall direction
- Clarify intellectual property rights position and strategy
- Provide feedback for budgeting and other forms of commercial discussion
- Provide connections to later stage funding
- Cover initial expenses for establishing a company

The kind of high-risk/potentially very high-gain research at the frontiers of knowledge promoted by the ERC has the potential to generate unexpected and novel opportunities

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[11] www.erc.eu; respondent interviews

[12] The term 'frontier research' reflects a new understanding of basic research. On one hand it denotes that basic research in science and technology is of critical importance to economic and social welfare, and on the other that research at and beyond the frontiers of understanding is an intrinsically risky venture, progressing on new and most exciting research areas, and is characterized by an absence of disciplinary boundaries.

for both business and society. The Proof of Concept funding is thus aimed at helping ERC grantees to bridge the gap between their research and the earliest stage of a marketable innovation.

The role of IP in good practise

As a result of searching for good practice in relation to market-oriented exploitation, it becomes clear that public authorities and universities alike focus increasingly on the crucial role of intellectual property in the exploitation of research results. While publishing details of novel technologies in peer reviewed science and technology journals increases the level of knowledge in society, no monopolistic right or proprietary know-how (i.e., patent or trade secret) – often the necessary basis for the previously discussed *type 1* market oriented exploitation – arises from such practice. One proxy for the growth in the European technology transfer market is to track EU patent applications at the European Patent Office. Between 1997 and 2007 the number of such applications grew 40 percent overall, with a growth of more than 70 percent for patents owned by universities.[13]

1.13.6. The European Commission's intellectual property activities[14]

When it comes to searching for good practice in connection with intellectual property and market-oriented exploitation, the EC itself has proprietary knowledge and experience in this field. While the function of the EC in relation to the funding of research projects across a wide range of scientific and technological fields through its framework programmes is generally known, it is perhaps less known that the organization in fact also itself is an active player in the field of research, carrying out research in a range of different fields, and also generates various types of intellectual property.

Since 2002 the Commission's Joint Research Centre (JRC) is mandated with the management of all Union-owned intellectual property rights (IPR) - patents, copyrights, trademarks, and other type of IPR. Hence, it is responsible for optimising the Union's IPR portfolio through efficient management, protection, promotion and potential exploitation of its IP assets. The JRC also provides support and advice to Commission services generating and using IPR, and organises or participates in events to raise awareness on intellectual property issues.

Conclusions on Good Practises

The examples of good practice in public support mechanisms of knowledge and technology transfer as well as market-oriented exploitation of research outcomes illustrate that there is only limited evidence of a real policy convergence. While there is no global trend to apply the exact same policies as solutions to similar problems, policy learning is definitely taking place leading to comparable policy solutions. Still, RDTI policies follow different overall policy approaches, e.g. the preference of indirect support measures in the Anglo-Saxon tradition vs. a tradition of more direct support systems in central or northern Europe. Although analyses and studies have shown that challenges are somewhat universal pivotal differences remain regarding their relevance and perception. Even though the approaches are different, the good practice examples clearly

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[13] http://www.oecd.org/dataoecd/59/45/42983414.pdf
[14] information from interviewed respondents; http://ec.europa.eu/dgs/jrc

display that there are three main challenges addressed by means of public support mechanisms in the area of market-oriented exploitation (of research outcomes):

- Lack of market pull for innovative technologies, especially the issue of lack of customers willing and being able to act as the technological avant-garde or early adopters
- Difficulties in transforming research outcome into innovations, especially the issue of missing links between (problem-oriented) basic research and industrial uptake in new research fields
- Lack of entrepreneurial activities resulting from publicly funded research, especially lack of growth-oriented spin-offs

While there is certainly a trend towards the general diversification of support mechanisms – which will be discussed later – it becomes evident that the traditional catalyst for safeguarding high wage countries' welfare by intensifying the links between research and industry through funding (i.e. co-financing) of collaborative research projects in either thematically specified or open funding programmes is still at the core of most support systems. However, public support systems increasingly acknowledge the issue of financial gaps ('valley of death') that are not and cannot be covered by co-financing of collaborative R&D projects, or more importantly that accompanying measures are necessary to fully tap the economic potential of publicly financed research; thus ultimately increasing the leverage effect of that funding.

In addressing the lack of market pull for especially radical innovations or technologies targeting new and still non-existing markets, RDTI policies are progressively utilising the potential of public procurement. The public administration provides a source of income (return-on-investment) to developers and manufacturers by acting as an early adopter, bridging the commercialisation 'valley of death'. By becoming a lead user, it can also validate a technology; thus signalling its validity and feasibility to potential private sector customers.

Before any given technology can be supported in coping with the difficulties of attracting investments in the early stages of market-oriented exploitation, it has to be developed into something investors or customers see as valuable. As the Canadian CICP programme shows, public procurers can act as test environments in case the technology primarily needs to be validated. However, there is the area of (problem-oriented) basic research as a source for economically relevant research outcome, which is especially relevant for radically new technologies. Traditional approaches – pairing researchers with companies in collaborative R&D projects – tend not to work in this case because companies often do not understand the technology, do not see a market or simply cannot take the economic risk as even with public funding they will have to make substantial investments. Support for the researchers to advance their research up to a point where companies are able to see and understand the possibilities is established more and more. This includes initiatives to generally raise researchers' level of entrepreneurial ways of thinking through university courses or personnel exchange, providing test systems, offer funding to projects explicitly bridging the gap between basic and applied research, creating publicity through road shows etc.

Apart from the issue of creating additional economic value for (almost) fully developed innovations through supporting market pull, RDTI policies are additionally creating support systems – instead of individual collateral funding schemes – that tailored to providing support throughout the full innovation cycle. The US-American SBIR programme is usually referenced as a role model as it provides the general opportunity to have one's research idea or concept to be supported all the way through the final technology, product or service being procured by the public administration – provided it qualifies for each of the successive funding schemes. However, the utilisation of public procurement of innovation in most EU Member States is less developed. Still, there is a trend to create coordinated national RDTI strategies, in which funding gaps are being closed and the transition of research between stages of the innovation cycles becomes possible.

In order to safeguard the leverage of public funded research – or research outcome in general – mentoring systems as part of the public support systems are increasingly used.

Successful technology transfer entails an entire framework of preconditions and associated functions. From the review of different actors in the field it is obvious that successful activities particularly emanate from partnerships in which public partners and private entities work together closely and in a continuous manner. University researchers provide the 'raw material' in the form of protectable inventions that constitute the fundamental part of the commercialisation process. It is also crucial that researchers, while themselves often likely not being the most suitable to drive the actual non-technical commercial phases of their projects; indeed have the urge to develop their research results into a marketable product. Intimate knowledge of the specifications of industry is often crucial for the constructive development of technologies, and under good conditions such knowledge is conveyed to the researcher either by an interested industrial actor or an intermediary.

It can be deduced that to invest, both public and private investors demand the existence of an intellectual property right – a patent or patent application – in an idea or invention. In high-risk projects such as technology transfer, it is often the only tangible indication of potential that is available for evaluation by a business partner or investor. It is also quite clear that real commitment by the different actors is needed for technology transfer to take place, which means that, e.g., members in advisory boards should be active and outcome managers should have hands-on experience of technology transfer to make technology transfer happen. It appears that the best results are achieved in cases where the driver is a private entity (Yissum, Yeda, etc.) or represents the interests of the private sector (Scottish Enterprise). For initiatives in which the driving actor does not itself directly benefit from the commercial undertakings, it is crucial that it has funding to subsist for a sustained period of time in order to improve practises and develop new in the face of different challenges that are bound to emerge in the course of complex multiplayer operations such as technology transfer. Apart from that fact, the initiative should also be located strategically within a larger context of continuous funding initiatives, so that – when sufficiently developed – there is another structure further down the commercial stream that can finance the project's development towards the market, if needed. That would include, e.g., venture capital and private equity investors. Successful technology transfer can also occur in the context of public-private partnerships, which is demonstrated by Scottish Enterprise's Proof of Concept Programme.

RECOMMENDATIONS

Based on the findings and analyses discussed above, the research team developed a number of recommendations whose implementation will not only help to improve the European Framework Programme support provided but in general increase the leverage effects of funding R&D projects with taxpayers' money. Despite the fact that these recommendations were discussed not only internally among the members of the research team but also with stakeholders (both policy makers and potential/actual beneficiaries) during a conference held in January 2013, the recommendations are to be viewed against the background of the fieldwork conducted. Consequently, it is important to keep in mind that they too refer to R&D projects and market-oriented exploitation processes rooted in the 6th Framework Programme while the issues analysed and addressed by recommendations might have already been solved (fully or partially) in FP7. However, the research team eliminated all recommendations that were linked to issues created or emerged in FP6 exclusively.

As it is the case with the findings and conclusions, the recommendations have to be understood as a system of interlinked elements rather than separate, stand-alone solutions. Nevertheless, the following chapters were designed to allow a structured access by introducing three different groups of potential solutions to the most pressing issues.

Smart funding serves as a headline for all recommendations that aim at improving the Framework Programmes in both their design and implementation with regard to increasing the commercial leverage public funding of R&D projects in industrial technologies can create. In contrast to that, the second group of recommendations labelled smart project management aims much more for the organisations involved in funded R&D projects but still acting on the maxim of how to improve the Framework Programme funding. While smart funding refers to the funding as such, smart project management refers to funding as helping organisations and consortiums to help themselves. The third group of recommendations, smart framework, contains recommendations whose implementation would help to improve the general framework conditions under which the research and market-oriented exploitation processes analysed operate. This category of recommendations is thus, of a more general nature. It is important to note that these recommendations address those parts of the framework conditions that can actually be affected by RDTI policies.

The chapters themselves contain a short/abridged version of the main findings (excluding findings for which there is no policy response available) and one or more recommendations that are designed to overcome the issue describe or increase the commercially relevant effects of EU-funded R&D projects.

1.14. SMART FUNDING

For many commercially successful projects the involvement of customers was crucial in terms of safeguarding the actual applicability and application of knowledge produced. The positive effect of involving customer in research projects somewhat depends on the flexibility with regard to the actual application area (narrow vs. wider).

► *Ensure the involvement of customers in projects at an early stage – not necessarily as partners but also as advisors – in order to help to decrease time-to-market and better define market needs for innovative products/services. Enforce the applicants to define the intended role of customers (i.e. integration, manufacturer, etc.) in a comprehensive way.*

Ideas are not confined to periods of validity and cannot be limited to a predetermined group of people or organisations. Funded project – for reasons of manageability – have to be. Consequently, successful research and market-oriented exploitation is only rarely linked to achieving a maximum but to intelligently deal with whatever was achieved by the time the funding period expired. In order to contribute – at least in some cases – to the full development and market-oriented exploitation of technologies, funding should be addressing ideas and not projects.

► *Allow projects that were identified or turned out as high-impact projects or projects whose research outcome will likely produce or contribute decisively to disruptive technologies to be supported throughout the whole innovation cycle, i.e. not necessarily only using funding. The support should be coordinated among all potential supporters (e.g. DGs, ERC, national funding agencies etc.) and be based on integrating RDTI policies with demand- and supply-side policies. The additional support could also take the form of prize money, which could extend publicity and thus create additional exploitation possibilities. All of this should limited to the 'elite' projects.*

► *Introduce specific programmes or calls for proof-of-concept and/or proof-of-value projects, when applicable. It might be reasonable to limit the programme or call to projects already funded. Consider a separate allocation for funding follow-up projects on a continuous basis if and when they originate from Commission funded collaborative R&D projects.*

► *A policy-based mechanism for additional – proof-of-concept – support should be introduced for on-going EU-funded projects that do not have commercial exploitation as primary goal. Such an instrument should provide the readiness to quickly respond to and support also unexpected commercially relevant research results. Recommended support would consist of funding to, e.g., protect commercially relevant results by way of filing patent applications, gauge the market situation, and to align the technical development with existing or projected market need.*

Good practise in the context of (European and other) public support for bringing research results to the market is strongly connected to the duly identification of commercially relevant research results, and their subsequent protection and management as intellectual property rights.

► *Consortia applying for EU-funding for the underpinning of commercialisation activities should be directed towards viably planning and budgeting for such activities at the* *proposal stage. Requirements at the call stage could include submitting comprehensive novelty and/or freedom to operate analyses for technologies to be developed and commercialised by the consortia, proof of relevant granted patents and/or the existence and strength of other intellectual assets related to technology, such as software.*

Success in market-oriented exploitation largely depends on the level of activity of the project partners. Lack of commitment, underperformance, and free-riding are major obstacles to research and market-oriented exploitation success.

► *Consider either dis-incentives for non-committed partners and/or underperformance/ freeriding to increase the number of partners strongly committed to the project to increase the potential for successful exploitation of research outcomes. Such dis-incentives could be reducing the subsidies or the exclusion of the consortium, etc.).*

Market-oriented exploitation pathways and their specific set of relevant impact factors depend to a large extent on the types (from basic to applied research) and fields (nanotechnologies, materials and production processes) of research.

► *With regard to the evaluation of proposals, the projects should be divided into at least two groups: (1) rather basic research and (2) rather applied research (it might be reasonable to ask the applicants to specifically develop their proposal for one type of project ex-ante). Consequently, the evaluation criteria 'scientific excellence' and 'commercial impact' will have to have different relevance. Still it is very important to have both groups of research projects funded as commercial conversion goes hand in hand with scientific excellence in the building of new markets.*

► *In relation to the evaluation of projects to be considered for EU-funding; stronger emphasis should be placed on identifying projects that show characteristics of and potential for the pathway type 1 (commercial conversion) to achieve a greater number of commercially successful projects. This would require both the design of novel funding instruments specifically dedicated to support consortium-based commercialisation efforts, as well as the contracting of evaluators with in-depth knowledge and hands-on experience of bringing research results to the market place.*

Despite the indisputable success of the Framework Programmes with regard to market-oriented exploitation in general, there are a number of research results and technologies not followed by any such activities. The findings of this study confirm that there are a number of impact factors potentially creating such a situation, especially with regard to a mismatch between organisational structure, change or capabilities and new technologies or economic potentials. While it is already possible to hand publicly funded research results to organisations outside the original research consortium for market-oriented exploitation to safeguard a macro-economic return-on-investment, it almost never happens.

► *Research outcome produced with the support of public funding could be transferred to the public domain if there is no evidence for market-oriented exploitation. I.e., research results can be handed over (e.g. via CORDIS marketplace) to any organisation that is seriously committed to doing so by the EC. This process could also follow a two-step design: the partner who 'owns' the research results (or respective IP) and is not willing or able to commercialise it hands it 'back' to the (former) consortium partners. If the* *consortium cannot agree on a commercialisation strategy or none of the partners wants to pursue its market-oriented exploitation, the EC declares it a public good.*

The findings of this study show that an effective and engaged project coordinator or manager is very often a key to project success in terms of leading and governing the consortium to achieve the outcomes aimed for in terms of market-oriented exploitation.

► *The EC could also think of the implementation of a training and coaching programme for project managers leading complex FP projects. Such a programme could use a certification system that could also influence the assessment within the evaluations of project applications in the future.*

Intellectual property is an essential vehicle for much of commercial conversion of research outcome (linear market-oriented exploitation), and therefore the European Commission should take a concerted stance on this very important issue.

► *Considering that the Joint Research Centre has considerable experience in the area of protecting and managing intellectual property, this department should be mandated to orchestrate important intellectual property related actions of the European Commission. Such a measure would, thus, reduce the risk of fragmented and therefore less effective actions relating to a much needed, overall EC IP strategy.*

1.15. SMART PROJECT MANAGEMENT

As R&D projects and the subsequent market-oriented exploitation processes are characterised by various uncertainties, the ability of organisations and consortia to manage respective risks – and in the event of a risk becoming an actual challenge or threat: emergencies – is crucial for success. In many cases analysed neither risk nor emergency management were fully developed. Instead, the partners and the project coordinator had to act ad-hoc and informed by a strategy and respective preparedness.

The drop-out of partners is one of the most common risks in R&D projects and very often endangering successful research and market-oriented exploitation – in particular when such partners have a key role function for the research and market-oriented exploitation process.

► *Risk and emergency management plans for the most likely critical/emergency situations should be mandatorily developed for every research proposal. Consortia should be obliged to analyse and disclose (in their proposal) the most likely risks and develop strategies to deal with these.*

► *Simplify the replacement of dropped-out partners in case they are necessary for market-oriented exploitation. A respective risk assessment and replacement strategy should be included in the risk and emergency management plan. The consortia's risk and emergency strategies could already include ideas for possible replacements.*

Potentially conflicting interests are common in cooperative R&D projects and can create major obstacles to successful market-oriented exploitation processes.

► *Make individual declarations of intentions and interest mandatory for consortium agreements (provide respective templates or checklists). They likely will have to be confidential (for the partner's eyes only).*

One characteristic of the research conducted (or rather its outcome) affecting the success of market-oriented exploitation is the level of novelty (e.g. research breakthroughs or radical innovations): a research breakthrough (or radical innovation) does either equip the organisations involved in its exploitation with vastly extended possibilities and opportunities (scope of the exploitation, new application areas etc.) or it sometimes blocks the chance of market-oriented exploitation (almost) completely (i.e. because of the lack of partners not included in the project from the beginning). Some cases had to adapt their research, innovation and exploitation strategy according to unexpected research outcomes. However, a fixed constellation of partners sometimes overrides the potential effects of modified exploitation strategies.

► *Authorise the project coordinator (in coordination with the partners) to change the project constellation during the project if unexpected and radically new research results – and consequently application opportunities – should require a re-configuration (i.e. additional partners necessary for exploitation later in the project).*

Knowing who will buy a technology, product or service and under which performance or price conditions, is certainly a – if not *the* – major impact factor for successful market-oriented exploitation. However, not every organisation is equally successful in obtaining or managing this type of knowledge so and the analyses conducted clearly indicate that there are several impact factors linked to market knowledge (or, in less applied R&D projects, awareness) that decide whether or not the market-oriented exploitation processes were successful.

► *Make the development and update of the projects' PUDK/PUDF mandatory, provide and apply a quality standard. In appropriate cases, funding instruments should incentivise the participants to align themselves towards the common goal of developing technologies commercially, despite their respective organisations having diverging underlying goals.*

► *Include a plan describing strategic intelligence activities (markets, competitors, technology and public perception monitoring where necessary) as a mandatory part of PUDK/PUDF (including updates and descriptions of how market-relevant issues will be fed back to project research and development activities) to create market knowledge and constant awareness of project partners.*

► *The PUDK/PUDF need to bring exploitation and dissemination together and separate them as often dissemination is the key to successful market-oriented exploitation and can be strategically used for exploiting research results in a commercial sense. Therefore, PUDK/PUDF should also explain strategies to deal with both internal IPR issues (e.g. publication vs. patenting) and external ones. Useful tools for disseminating research results to boost market-oriented exploitation should be a compulsory element as well.*

► *The European Commission could appoint an external expert providing market knowledge via market analysis to the project should the consortium require so. The expert's budget could be provided as part of a mentoring system.*

1.16. SMART FRAMEWORK

Despite the fact that standardisation and regulation are widely considered highly effective impact factors for successful research and market-oriented exploitation, there is very limited evidence for active handling or even awareness of project partners (not limited to research or higher education organisations).

► *Consider the establishment of a monitoring mechanism (at EC level for research fields and/or project level for individual issues) for accompanying projects with regard to the identification of regulations or standards or norms or public opinions that may hinder or prevent the eventual market-oriented exploitation. The importance of this issue may depend on the type of research (and may not be necessary for strong basic research projects).*

► *Monitor projects for potential standardisation activities and impact of standards developed and implemented by others in order to safeguard the market penetration and to ensure that new players can enter markets. Safeguard and enable an adequate involvement of and/or access to standardisation activities and committees (especially for SME or generally new players) and links to relevant units within the EC (DG Enterprise).*

Market-oriented exploitation often suffers from weak market pull because customers lack the absorptive capacity, knowledge necessary to integrate a new technology into existing production processes or are simply not willing to assume the risk, perceived or actual.

► *Include pre-commercial procurement as a means to complete market-oriented exploitation processes by creating demand.*

Industrial technologies R&D projects funded by the European Framework Programmes are quite successful with regard to market-oriented exploitation. However, their success is substantially depending on previous successful exploitation processes, i.e. some organisations manage to accumulate process and market knowledge. EU-funded R&D projects tend to discourage organisations without established networks from participating, which can be linked to perceived and actual obstacles to commercially exploit research outcome produced in the context of such projects.

► *Provide detailed information on best practise in market-oriented exploitation processes (publications, road shows, data bases etc.). Establish a learning feedback mechanism between best practice examples and other projects, especially when first-time participants are involved. Use best practice new product introduction tools and techniques practised by industry to increase the probability of a successful commercial outcome, introduce this methodology early in the project, i.e. a stage gate process independently assessed.*

Consortia, project coordinators or partners of successful and successfully commercialised R&D projects have a unique and vast knowledge.

► *This knowledge should be made public – or at least available to others funded with European public money – in order to transform the Framework Programmes into a learning system. This could take several forms from annual conferences on specific issues (along different technologies, research fields or activities of market-oriented exploitation)* *to individual consultations including a consortium, a representative of the European Commission and a representative of a success story.*

CASE STUDIES

This chapter presents a selection of 10 cases of commercialisation processes.

1.17. ALTEX (CLEARWELD)

THE PROJECT

The ALTEX project started in 2005 and was financed by the 6th European Framework Program. The Project involved 12 partners chiefly from Italy and United Kingdom in textile, mattress and tool engineering manufacturing industries and furniture retailers under the coordination of TWI Limited. TWI is a global leader in technology engineering providing research and consultancy. ALTEX looked at the development of laser welding techniques for textiles using Clearweld.

Protective Clothing for workers in dangerous environments requires special joining techniques providing barriers to particles, liquids or gases. Additionally, the textile product manufacturing sector for outdoor waterproof sports and leisure wear in Europe is declining under the competition of labour intensive production in East Asian countries. Therefore the promotion of innovative textile processing and welding technology using laser technologies is the main goal of the ALTEX project, expecting to develop cost efficient ways to produce waterproof seams for garments and mattresses in order to strengthen European competitiveness on the global market. TWI Limited already developed Clearweld, an enabling laser technique of welding plastics and textiles before ALTEX. There exits alternative sealing methods, however they rely on an additional tape layer between the fabrics and the seam. The current procedures are time consuming, highly labour intensive and the use of tape is limited in applications using complex 3D seams. Laser welding offers a method of making sealed seams without using additional film at the joint. The process melts a thin layer of the fabrics without affecting the outer surfaces by transmitting the laser energy through the outer fibres. The welding equipment contains a reconfigurable table to fix the fabric parts in the required location and a laser beam delivery unit to provide controlled laser heating and pressure application along the textile seams.

While this technique was successfully commercialized in production for welding plastic, applications on textiles was not in production by the time of ALTEX. Apart from producing concrete commercial products like waterproof jackets and bed mattresses using Clearweld for market exploitation, ALTEX intended to look for new joining techniques and automation for furniture manufacture and applications on 3D products.

MARKET-ORIENT EXPLOITATION

The project ended in 2007 and a prototype of automated textile welding station has been build and there have been several presentations on conferences where the advantages of laser welding and the resulting waterproof garments and bed mattresses were presented. However, due to lack of customer interest, the dissemination of Clearweld in textile manufacturing industry still could not been realized. The development of machines that could process 3D textile sealing was put on active standby as TWI pursued to promote other promising products on their portfolio.

Although, there have not been a breakthrough in the market-oriented exploitation of the original idea, the technology used in ALTEX have been applied in different areas and resulted in new projects in other fields funded either nationally or by FP7. These new projects either are using the partners network or the technology from ALTEX.

In February 2008 LEAPFROG IP (FP6) was started, following the advice of one of the ALTEX partners. The project aimed at developing joining techniques for natural and synthetic materials. The project went successfully through a technical development and ended up with some demonstrations of material preparation for the jacket. However, the industry didn't show much interest in further market exploitation.

A new project was started by a bed manufacturing company in June 2009 financed by the UK government on manufacturing automation by using robotic welding systems. It led to new product designs by replacing buttons and stiches with welds and achieved a reduction in waste material, through recycling procedures. This project also leads to smaller projects on medical textile applications that TWI is supposed to lead to market-oriented exploitation.

Another project that resulted from ALTEX was the project on textile finishing that resulted in a FP7 project. The fashion industry has become interested in applying Clearweld. Together with a partner at Central St. Martins College in London, they have come with a range of applications of materials joining techniques in fabric manufacturing with several demonstrations. The wider benefit of this technique is in recycling, because the fabric is composed of single material. The industry expressed their clear interest in further market-oriented exploitation.

Other applications in gloves, shoes, airbags, inflatables, airships (a new project proposal in FP7), neck braces, furniture applications (a new project proposal in FP7) are considered for further development in the future.

Lessons learnt

The project results influenced further work with many subsequent applications in a number of industries with projects resulting in demonstration activities and further project proposals. Most important lesson learned seems to be the knowledge of technology and its possible applications and limitations. The combination of knowledge learned in ALTEX on automation and the knowledge on welding techniques for textiles enable to do further develop the technology successfully in other projects. In this way subsequent projects used this knowledge and experience in delivering new technologies for many applications. Another important lesson was the establishment of a network of partners along the value chain that kept on delivering solutions to different industries and preparation of subsequent projects.

In the post project stage a clear need for further financing emerged that could bring developed knowledge closer to the market and finally result in full market-oriented exploitation. This need was met by the Knowledge Transfer Partnership in the UK, which gave the opportunity to take the developments closer to the industry.

FACT SHEET

	type of information	information
project	project title acronym	ALTEX
	FP	6
	thematic area/priority	Not NMP (SME-1 Research for SMEs)
	instrument/type of action	Cooperative
	number of partners	12
	main project outcome	Manufacturing processes; know how

case study	product, technology, service that was/is going to be commercialised	plastics laser welding technology named Clearweld® (http://www.clearweld.com/index.html)
	main commercialising organisation	TWI LIMITED – POLYMERS, UK, independent research and technology organisations. Engineering solutions in structures incorporating welding and associated technologies (surfacing, coating, cutting, etc.)
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	National and European
	target market (sector)	Furniture industry, fashion industry, textile industry, medical flexible materials
	state of market-oriented exploitation	It varies, depending on the product: some are waiting on the shelf, some are available in the market, some are under further development
	type of pathway	full commercial conversion; pending commercial conversion
	main story steps	• ALTEX started in November, 2005 went through December, 2007. 6 months before the end of the project partners had 2 demonstration pieces: the waterproof garment and the bed mattress. The demonstration phase was fairly unproblematic. • In February 2008 LEAPFROG IP (FP6) was started, following the advice of one of the ALTEX partners. It was quite easy to demonstrate, but much more difficult to exploit in production. • Subsequently the ALTEX project has led to a wide range of projects such as in bed manufacturing, medical flexible products, textile finishing. Currently, increasing interest could be found in various textile and furniture manufacturing sectors, where further developments are expected in the future.

	main market-oriented exploitation success factors	• Additional funding for bringing research closer to the market • Committed engagement with the big industry (potential customer) • Valuable contacts among the consortium partners
	main market-oriented exploitation obstacles	• Scaling up; • Lack of interest from the industry

1.18. AMBIO

THE PROJECT

AMBIO was an Integrated Project with a consortium of 31 Partners (for details see fact sheet below), funded under the 6th Framework Programme of the European Union. It brought together knowledge from polymer chemistry, surface science, and marine biology with experienced coating manufacturers and their customers (end-users) from industries, small and medium sized enterprises, and research institutes across Europe. The overall aim of the AMBIO project was to develop innovative, non-biocidal solutions for biofouling. To this end, a knowledge base was aimed for connecting interfacial properties with adhesion of marine organisms to directly inform the development of new materials and surface designs, combining state-of-the-art surface- and nanoanalytics. The identification and selection of successful coating technologies included laboratory and field-testing, scale-up and demonstration activities. The project was designed to lead to market-oriented exploitation of the results by means of marketable end-user products. Therefore, the AMBIO project followed a multidisciplinary approach including the composition of the consortium, open access to advanced analytical tools, and a "knowledge driven" strategy for engineering novel fouling-resistant solutions.

AMBIO resulted in the development of a variety of potential technological solutions to the issue of biofouling that led to a total of 10 prototype technologies for different applications. At least three successful, patented coating technologies are currently available for commercial exploitation, a) the CNT-siloxane dispersions marketed as Biocyl™ by Nanocyl, b) the SiOx-like coatings which can be deposited on optical windows by Teer, c) the sol-gel technology introduced by TNO which is available for direct application to propellers by Original Equipment Manufacturers.

MARKET-ORIENTED EXPLOITATION

AMBIO aimed to provide a source of innovation for relevant EU industries. EU companies are world-leaders in anti-biofouling coating technology with 70% of the global market share. However, innovation is vital to coatings manufacturers who constantly reformulate their products to differentiate themselves from the competition. Innovation is especially important in the current legislative climate in which environmentally-benign products are increasingly sought. Emerging technologies as those developed in AMBIO (i.e. nanostructuring of coatings) now provide such a source of innovation. It has been estimated that in 10 years from now, 30% of paint industry sales in Europe will rely on nanotechnology applications in so-called 'smart' coatings, including those destined for marine and freshwater applications. Some Partners perceive new business opportunities to enter new markets previously unknown to them e.g. Teer Ltd has the opportunity to provide commercial coating services to the marine instruments market, and Nanocyl is now able to provide dispersions of CNTs for use in the manufacture of marine antifouling coatings. AKZO anticipates benefits in the area of protective coatings for power inlets and aquaculture through their exposure to these markets resulting from the joint work they did in the project with KEMA and VAL respectively. Other industrial partners have also benefitted from the project through the introduction of new evaluation tools, such as the stereological analysis of fouling communities or the introduction of the accelerated test patching procedures (AKZO). Finally, several companies in the project (OCN, VAL, KIMAB, KEMA, TNO) have been enabled to obtain commercial benefits, e.g. in consultancy services, through their improved knowledge base and competencies.

As a largely research-driven R&D project, AMBIO was designed and coordinated by a university (Birmingham). There was extensive experience in cooperation with the project partners in a number of R&D projects prior to AMBIO. Basically, every research organisation invited to the consortium brought their main, long-time industry partners to the table. By including the whole value chain but avoiding the participation of competitors and including industrial partners that had strong ties to the research organisations at the centre of the project, the commitment and activity levels were high throughout the project. Market-oriented exploitation was part of the overall project design and the danger of conflicting interests was eliminated by establishing an internal peer review process (strategy board) to review and approve of every exploitation process aimed for by one or more of the partners.

The research, development and testing stages were conducted without (unexpected) technological set-backs. Every work package produced at least one or two feasible innovations that were tested by the industry partners and almost instantly developed into marketable solutions. From the beginning, the market-oriented exploitation was prepared by the introduction of an end-user reference group, which safeguarded the applicability of any technology developed in both the broader sense and as part of their individual industrial portfolio. The next important step was to include a number of dissemination steps from publications to the joint workshops and symposiums with potential customers. All technologies developed were also discussed and their application potential evaluated annually in internal training seminars and workshops. With this back-up in terms of an early exposure of the research outcome to the interested public and customers especially, the next step was the individual development of marketable products by the companies involved in AMBIO. Their economic impact has been partially constrained by the global economic crisis but nanocoatings are continuing to grow faster than the overall coatings market, most notably in Asia-Pacific, the largest current market for paints and coatings.

Lessons learnt

The fast and direct market-oriented exploitation heavily relied on a smooth cooperation between all partners and strongly facilitated by the coordinator. The composition and coordination of the consortium was designed and executed in such a thoughtful manner that no frictions occurred. Still, the project was equipped with mechanisms and procedures to balance possible conflicts but there were never any conflicts to be solved. Already halfway through the project's duration several industrial applications became apparent. Since the companies involved were not competitors, the market-oriented exploitation possibilities were considered to have been fairly easily split according to the companies' respective areas of application.

AMBIO is considered – not only by its participants – a success with regard to both the research conducted and its market-oriented exploitation. As an integrated project with a comparably large number of project partners the role of the project coordinator and the overall management proved to be especially effective. Apart from that, the overall design of all relevant processes allowed for a fruitful coexistence of organisations with primarily scientific and economic objectives. In addition, the strong commitment of all partners was a major success factor. However, AMBIO would not have been successful had there not been a substantial demand already in the beginning of the project’s conceptualisation and design, which translated into a respective market pull, safeguarded by including companies with a major, persistent interest in the technological solution rather than using the project as a testbed or for technology scanning. The strong commercial interest was sustained by allowing the industry partners to define their ideas of potentially valuable applications and by giving them access to dissemination decisions through participation in a project-related steering board. Both mechanisms created a maximum of control, which in turn created the basis for mutual trust and open cooperation.

FACT SHEET

	type of information	information
project	project title acronym	AMBIO
	FP	6
	thematic area/priority	NMP1
	instrument/type of action	IP
	number of partners	32
	main project outcome	new formulations (materials and mechanisms) for non-biocidal surface treatment

market-oriented exploitation case study	products, technologies, services commercially exploited	non-toxic (non-biocidal), nano-structured coatings for maritime vessels
	main commercialising organisation	International Paint (Akzo-Nobel) and TEER Coating Ltd. (companies manufacturing coatings and vessels involved in the project)
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	global
	target market (sector)	maritime industries
	state of market-oriented exploitation	available
	type of pathway	full commercial conversion
	market-oriented exploitation process	• project started with the idea of a single researcher who is one of the central researchers in the field and became the project's coordinator • FP6 allowed the coordinator to make the most of his experience and expertise in terms of actively steering the project, which he did successfully • although largely research-driven all partners were committed to market-oriented exploitation (market-oriented exploitation was already part of the consortium agreement) • the research produced feasible (based on a tested prototype) technological solutions whose exploitation was agreed among the partners through an internal peer-review process (including potential patents and other forms of exploitation such as publications) • industry partners successfully filed 5 patents • application fields were divided between industry partners along their core businesses (yachts, large vessels, buoys, oil rigs etc.) • successful patenting was directly followed by setting up industrial production facilities • 2 of the industry partners immediately went into mass production

	main market-oriented exploitation success factors	• the consortium members represented a variety of disciplines and managed to utilise the multidisciplinarity for mutual synergies • project coordinator (including the extended authorities compared to previous FP) • establishment of an end-user group (companies not involved in the project but potential customers) • permanent communication between partners and sub-projects
	main market-oriented exploitation obstacles	• career changes (e.g. they had three different individuals serving as 'director for technology transfer', which in turn limited the impact such a person could have had)

1.19. CD-TREATMENT

THE PROJECT

The project concerned duplex technology and was aimed at development of the technology and equipment for continuous duplex treatment of hot forging tools and studying the wear behaviour of tools coated with composite layers e.g. nitrided case/PVD coatings. The tribological properties of tools and components are improved by wear resistant coatings deposited by thermochemical processing (nitriding, nitrocarburizing) or physical vapour deposition (PVD) technologies. In terms of market exploitation, the aim was to establish a special technology centre, in which the research result could be implemented and distributed to the industries.

The project started in 2002 and involved partners from 7 countries. It was coordinated by the Institute for Sustainable Technology (Poland) and included universities from France and Germany. The composition of the partners included the whole value chain, with factories in Spain and Poland responsible for testing the technology developed during the project. However, only the latter was a partner of the project.

Within Institute for Sustainable Technology there were two important steps in the projects including Building of hybrid technological systems and Development of hybrid surfaces technologies for specific industry application.

In the beginning of the project partners signed the consortium agreement, which regulated the issues on market-oriented exploitation. Confidentiality agreement was part of the consortium agreement to avoid potential interest conflicts. The market monitoring and analysis was not done in the project. Partners claim that it was important to obtain only the opinion of particular enterprises, regarding their needs. In this way the entire market macro-analysis was not undertaken and the focus was on the specific industrial companies. This was done both during the project and after the project finished.

MARKET-ORIENTED EXPLOITATION

The university of science and technology of Lille participated in the market-oriented exploitation process and – as a first step – successfully filed a patent for the technology: "Method for controlling plasma-assisted nitriding process and the system implementing said method".

The project results were then disseminated through different international conferences, including the EMRAS spring meeting in Strasbourg in 2003 and a congress organised in Shanghai in 2004, where the researchers presented the project results.

The most important step for market-oriented exploitation of technology was the creation of the Plasma Technology Center (PTC) at the Institute for Sustainable Technologies using the developed technology. This corresponds to the original intention of the project to create an effective way for technology diffusion. Within the PTC two crucial tasks were performed: The building of hybrid technological systems and the development of hybrid surface technologies for specific industry applications. The PCT provide services to various industries. According to different demands in those industries, the process may need to be adapted to meet special requirements.

The administrative work in the patenting process was mainly done by University of Lille but also owned by the Institute for Sustainable Technologies at the beginning. Further along the process the Institute decided to forfeit the patent to University of Lille due to changes of their activity fields. But the activities of PTC are not affected and PTC continues to provide technology assistance according to orders from industries. Currently, a spin-off out of PTC is being considered.

Lessons learnt

The main challenge regarding the market-oriented exploitation of the project results was the perceived lack of interest from the industry, despite the efforts put in presentations of technical and economic benefits to potential customers. This is mainly attributed to the fact that potential customers are more focused on production with use of existing methods and are less interested in applying new technologies, due to various reasons. Even when the positive effects of applying the technology are visible (as in this project), it is generally very difficult to convince the industry to apply new technologies. The PCT put a huge effort to convince industrial partners and ultimately managed to apply the technology to some extent, due to proving the highly positive economic effects of the technology. While patenting procedures are considered as being very time consuming it is still considered a necessary effort as a signal to the industry.

Another lesson was the issue of organisational setup. During the project the technology developed was the core technology for the surface engineering at respective surface engineering department in the Institute for Sustainable Technology but it was not the core technology for the whole institute. Neither was it a core technology for the other partners engaged in the project. Consequently, building a new organisational infrastructure (PCT) around that technology and continuing this approach by preparing possible spin-offs was the only way to create the suitable organisational context for a successful market-oriented exploitation, which would not have been possible within the existing organisational framework. Therefore establishing PCT was certainly the most important success factor regarding and (future) market-oriented exploitation.

FACT SHEET

	type of information	information
project	project title acronym	CDTREATMENT
	FP	5
	thematic area/priority	Key Action Innovative Products, Processes and Organisation
	instrument/type of action	Cost-sharing contracts
	number of partners	8
	main project outcome	Services (development of hybrid surfaces technologies for specific industry application, but also other technologies) provided to the industry by the Plasma Technology Center (that was created as a result of the project) and a patent on the technology for a continuous duplex treatment of hot forging tools, was filed by the university partner.

case study	product, technology, service that was/is going to be commercialised	Industry service through the specially created Plasma Technology Center.
	main commercialising organisation	Institute for Sustainable Technologies – National Research Institute (ITeE-PIB) (Poland)
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	National and European
	target market (sector)	Industrial equipment
	state of market-oriented exploitation	Market entry
	type of pathway	full commercial conversion
	main story steps	• Consortium agreement regulated the issues on market-oriented exploitation. • Confidentiality agreement was part of the consortium agreement. • The project results were disseminated through different international conferences • Potential technical users were contacted. • Manufacturers were engaged in tests conducted in Poland and in Spain (2004 – 2005). • Plasma Technology Center (PTC) at the Institute for Sustainable Technologies in Radom created as a follow up (01.2004). • Cooperation between two partners in the patent application. • Spin-off out of PTC is considered.

	main market-oriented exploitation success factors	• Consortium agreement • Creation of an organisational entity (PTC) responsible for market-oriented exploitation of the service and knowledge; • Study of industry needs; • Cooperation with industrial partners in the project; • Industry interested in the product/service; • Inclusion of the entire value chain in the consortium
	main market-oriented exploitation obstacles	• Inadequate organisational form (no-spin off); • Time-consuming efforts to commercialize; • Industry focused on mainstream production rather than application of new technologies; • Time-consuming patenting procedure

1.20. DINAMICS (LAMBDA)

THE PROJECT

The consortium of this Integrated Project in FP6 included major stakeholders from the relevant branches, end users and production system suppliers, ICT providers, SME and RTD performers, including academic and research institutes from 8 countries. Every partner had his module/work package but there was a common goal, they elaborated and concretised in the first year of the project. One research institution "assisted" the coordinator with organising workshops for the whole consortium within a work package on "information transfer" to get everyone in line with the project goals in terms of "speaking a common language", as there were involved partners not only with different institutional background, but from different disciplines (bio, physics, nano-oriented partners, etc.).

The objective of the project was to develop, through the combination of nanotechnology, microsystem technology and biochip technology, a forward looking warning system. At the start of the project "User requirement specifications" and "Functional specifications" that translated these requirements into particular specification for type of pathogens included, response time, sensitivity, reliability, functionality and ease of use were defined by studying literature and employing an advisory board and making engineering trade-offs. In order to develop a functioning automatic system for the analysis of drinking water for pathogens, experts in several scientific disciplines have been cooperating. The project has been divided into three phases; in the first phase several solutions for each of the sub-functions of the system were explored, in the second phase the functioning solutions were integrated, and in the last phase the system was tested and validated. The main challenge occurred during the project was firstly the fast reduction of a large sample fluid volume (100L) to a small analytical volume (< 1ml) that can be processed on a microfluidic platform and secondly the integration of several technologies (nanotechnology, microfluidics, microelectronics, and molecular biology) with often contradicting requirements. A rigorous systems engineering approach was necessary to overcome this difficulties. During the four year project period a prototype device for the detection of pathogens in drinking water integrated with a warning system that will automatically alert authorities through different communication channels was developed and assembled.

THE MARKET-ORIENTED EXPLOITATION

The coordinating company (Lambda GmbH – a company in the field of DNA-chip-technology) was the one that successfully exploited results of the project (lab-on-a-chip platform and device for the detection of pathogens in liquids integrated with a warning system). The company´s core competence lies in the development and production of ready-to-use-kits for the detection of bacteria and viruses with a focus on the diagnosis of infection. Further fields of research and development include food diagnostics and quality control products for the pharmaceutical industry. The company aims for the worldwide establishment of DNA-chip-technology in diagnosis and for that purpose we develop new platforms and integrated analysis systems.

The research and development in the project aimed at the safety-market (quality assurance). The development went well as planned and every partner followed his defined tasks. One university involved developed an alternative approach ("backup plan"), but it turned out to be not market-oriented enough. Accordingly, the coordinating company developed in-house following its own and original approach, which turned out as the better and faster option. During the project they had to struggle with several drop-outs of partners for different reasons (bankruptcy, cost-benefit-imbalance due to pro-longed contract negotiations with the EC, etc.). One drop-out of an SME that went bankrupt was very threatening for the exploitation and respective timing due to its crucial task (technology integration) in the project. Nevertheless they managed to involve another company for the integration work, but with somewhat delay.

Most of the crucial steps towards the market-oriented exploitation have been done while the project duration in this case. In the end of the project, when presenting a poster on its project work at a conference, the company met another company, which was not part of the consortium, presenting a poster on an application in parallel. This other company had already another application (reagents) and they were interested to buy the developed device and then they identified a joint exploitation potential of their applications. In the end they combined their applications to a new product (device). Each of them has its own IPRs.

The application fields of the product are medical diagnostics of infectious diseases but also the food industry and pharmaceutical testing.

Lessons learned

Most of the crucial steps towards the market-oriented exploitation have been done while the project duration in this case. The coordinating company managed to realise the market-oriented exploitation of a developed lab-on-a-chip platform and device for the detection of pathogens in liquids even though the project members had to struggle with several drop-outs of partners. One main reason for the success was surely that the company was the coordinator of the project and besides had clearly defined tasks for each partner as well as a clear goal for the exploitation. One drop-out was very threatening for the exploitation and respective timing due to its crucial task (technology integration) in the project. Nevertheless the project team managed to involve another company for the integration work, but with somewhat delay. To summarise the main success factor was definitely the coordination company with a clear exploitation goal and enough experience in managing such research projects.

FACT SHEET

	type of information	information
project	project title acronym	DINAMICS
	FP	6
	thematic area/priority	NMP4
	instrument/type of action	IP
	number of partners	14
	main project outcome	sensor technology (diagnostics)

case study	product, technology, service that was/is going to be commercialised	lab-on-a-chip platform and device for diagnostics
	main commercialising organisation	Lambda GmbH (subsidiary of Greiner Bio-One GmbH) a company in the field of DNA-chip-technology in diagnostics
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	Commercialised in cooperation with another company not involved in the project by combining their two different technologies/approaches
	target market (region)	global
	target market (sector)	medical engineering
	state of market-oriented exploitation	available
	type of pathway	full commercial conversion
	main story steps	• At first the project aimed at safety-market (quality assurance), but the EC/PO was interested to target the security-market (background: potential bioterrorism, market potential unclear). Development of the technology was done for both markets in the end; the company always was developing for the safety-market (the market they aimed at primarily, with much more exploitation potential). • Every partner had his module/work package but there was a common goal, they elaborated and concretised in the first year of the project. • One research institution “assisted” the coordinator with organising workshops for the whole consortium within a work package on “information transfer” to get everyone in line with the project goals in terms of “speaking a common language” (bio, physics, nano-oriented partners…). • During the project they had to struggle with various drop-outs of partners for different reasons (bankruptcy, cost-benefit-imbalance due to prolonged contract negotiations with the EC, etc.)

		• One SME that went bankrupt had a crucial task (integration task), that implied a major threat to the exploitation and respective timing. Nevertheless they managed to involve another company for the integration work, but with somewhat delay. • One university involved developed an alternative approach ("backup plan"), but this was not market-oriented enough, the coordinating company developed in-house following its own/original approach, which was the better and faster option. • When presenting a poster on its project work at a conference the company met another company (not part of the consortium) presenting a poster on an application in parallel. They identified a joint exploitation potential of their applications and in the end they combined their applications to a new product (device).
	main market-oriented exploitation success factors	• company managed to maintain their research focus despite the EC wanted them to go in another direction • company was project coordinator • project was industry-driven • market knowledge and orientation • no competitors involved in the project • no end-users were involved • consortium managed to continue despite partners dropping out due to slightly redundant competences available • technology integrator was part of the consortium
	main market-oriented exploitation obstacles	• Company has been pushed by EC to develop for the safety market (although they planned to target the security market) • Several drop-outs of SME partners during the project

1.21. EUROLIFEFROM (VILLA REAL LTD.)

THE PROJECT

EurolifeFrom financed between 2001 and 2005 form FP 5 was defined as a Probabilistic Approach for Predicting Life Cycle Costs (LCC) and Performance (LCCP) of Buildings and Civil Infrastructure project. The construction industry is a major consumer of natural resources. The inability to predict performance reliably can result in waste or costly premature deterioration. Life cycle analysis enables the life cycle cost and performance, LCCP, to be optimised.

The principal objective of the project was the development of a generic model for predicting life cycle costs and performance. This model is applicable initially to the design of buildings and structures to optimise the life cycle costs and latterly to optimise interventions through maintenance and repair. The project had 14 partners from 8 countries and was originated in Villa Real - an engineering and consulting office, which was also a major partner in the project. In 2001, a task group was established by the EC DG Enterprise to "Draw up recommendations and guidelines on Life Cycle Costs - LCC of construction aimed at improving the sustainability of the built environment.

The group tried to find models for practical application of sustainable construction based on present value of economic and environmental factors. The design process was mapped using case studies, to determine how LCCP could be incorporated most effectively. The approach should include the assessment of environmental and other socio-economic factors.

The intended output was to be a software package for design and for monitoring and feedback of data.

MARKET-ORIENTED EXPLOITATION

The project was considered very ambitious and also valued by DG Enterprise Industry. Nevertheless several factors influenced the unsatisfactory completion. We may list here especially the fact that part of the software developed was left unfinished, without validation, verification and audit. Secondly the proprietary/license agreement was prepared but never signed by the partners. In this way all rights were left globally open to the partners. Finally the instruction manual for the software has never been completed. It was also pointed that the Commission itself could have been more careful and strict in monitoring of the agreed deliverables.

For the above reasons the market-oriented exploitation of the results has been difficult and laborious.

VILLA REAL LTD has some dissemination knowledge about the software in several international conferences, which created interest in the US and Japan, but did not lead to the expected market-oriented exploitation. Also discussions with several leading Finish companies working with construction design and execution software were held without further market-oriented exploitation, yet.

Finally, a package of models to enable a lifetime design process utilising the LCCP approach was developed. The related software tools are available together with extensive documentation, and Villa Real has global rights to this package. The commercial software and services under the EU-wide brand name FutureConstruct® were registered and introduced to the market.

Available on line from Villa Real currently is FutureConstruct® Sustain. This system and software allows for a total impact assessment; not on environmental domain alone but also on occupational, mobility and societal domains. It is also a step towards a Total LCC (Life Cycle Costing) computing, allowing for computation of impacts in different life cycles (stages) corresponding to the period of interest.

LESSONS LEARNT

The main lesson to be underlined is the necessity for continued engagement of all project partners in development of required deliverables. If this condition is not maintained along the project implementation with use of different methods - the entire undertaking is endangered. Another important factor in this context is the role of the Commission, both on policy level and project monitoring level. The project was set with ambitious policy targets. Databases and technologies to achieve these targets have been developed but in many cases technological development is not enough. European policies, standards and regulations should also be affected, forcing the regulators and the market to apply LCCP solutions.

FACT SHEET

	type of information	information
project	project title acronym	EUROLIFEFROM
	FP	5
	thematic area/priority	Key Action Innovative Products, Processes and Organisation
	instrument/type of action	Cost-sharing contracts
	number of partners	14
	main project outcome	A cost database; A service life database including statistical quantification of parameters used in the predictive models.

case study	product, technology, service that was/is going to be commercialised	FutureConstruct® software tool for calculating life cycle costs and performance of buildings
	main commercialising organisation	Villa Real LTD Finnish engineering and consulting company, servicing international clientele of the Construction and Real Estate Cluster - CREC
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	
	target market (region)	National, European
	target market (sector)	Construction industry
	state of market-oriented exploitation	Available on the market
	type of pathway	direct commercial transformation including additional research activities
	main story steps	• In 2001, a task group TG4 was established by the EC DG Enterprise to "Draw up recommendations and guidelines on Life Cycle Costs - LCC of construction aimed at improving the sustainability of the built environment". • The group tried to find models for practical application of sustainable construction based on present value – PV of economic and environmental factors. The final report Life cycle costs in Construction were approved in 2003. • Dissemination of knowledge about the software in several international conferences created interest in Finland, US and Japan, but did not lead to market-oriented exploitation as expected.
	main market-oriented exploitation success factors	• Strategic dissemination;

	main market-oriented exploitation obstacles	• Part of the software developed was left unfinished, validated, verified, and audited. • Flawed coordination; • Partners who do not honour their commitment in the project; • Lack of time and funding for taking further steps; • Imperfect monitoring from the side of Commission; • Lack of dedication;

1.22. EURO ShoE

The project

The EURO ShoE project was a holistic industrial-oriented approach in order to support and advance the European shoe industry, by implementing the "mass customised" shoe. Innovations in production and management processes have been aspired in favour of a customer-oriented industry. Overall 32 partners of various application areas were involved in the research activities. The fact that nearly all consortium members have been previously involved in exploitation and market-oriented exploitation activities, affected the project in a positive way. However, knowledge transfer was rather complicated due to divergences in technology level of and the existence of competitors among the consortium partners.

Due to the technological diversity of the participants (the whole value chain was covered), the focuses on exploitation of R&D results have been differing. Therefore the planning and realisation of exploitation and market-oriented exploitation issues was done in the early stage of the project, and were geared in direction of the individual needs of each member. The specific activities have been imbedded in a decided Working Package to understand the market demand and find a market approach. The early handling enabled the successful market-oriented exploitation of a multitude of technical solutions developed during the project.

Market-oriented exploitation

The adoption of the exploitation plan was done towards the requirements of the project progress throughout the whole project duration in intervals of 6-12 months. Gaining flexibility from this measure, both the individual and the conjoint exploitation approaches grew stronger. Dissemination and exploitation meetings were held during the second half of the project duration once every quarter. Also feasibility studies and cost-benefit analysis have been conducted along the dissemination of partial results. Market readiness could be confirmed, but depending on market segment there are slight deviations due to regional demand and preferences. In addition, one third of the project partners continued their partnership in a follow-up project.

Lessons learnt

With a clear and undisturbed path of technology development, the importance of market knowledge and awareness is not declining. Dissemination activities can help to maximise the positive economic effects of a successful market-oriented exploitation if there are utilised strategically to test the expectable market pull and potentially necessary modifications.

FACT SHEET

	type of information	information
project	project title acronym	EURO ShoE
	FP	5
	thematic area/priority	-
	instrument/type of action	IP
	number of partners	33
	main project outcome	Mass customisation of shoes; improve shoes and the providing industries
case study	product, technology, service that was/is going to be commercialised	Improved products and processes among the whole value chain (e.g. software applications, production technique)
	main commercialising organisation	Various companies developing/producing technologies
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	
	target market (region)	Europe
	target market (sector)	Shoe industry
	state of market-oriented exploitation	available
	main story steps	• Different technological approaches resulted in divergent, individual exploitation interests • Planning and implementation of exploitation concerns were adjusted during the project duration • Numbers of consortia meetings and compulsive exploitation meetings in the second period of the project • Feasibility studies occurred during the whole project duration (usually combined with the presentation of intermediate results) • Informal communication simplified exchange of information
	type of pathway	full commercial conversion
	main market-oriented exploitation success factors	• Extensive market research activities caused extensive knowledge of the market demands • The whole value-chain was represented • Flexibility with regard to individual market-oriented exploitation issues • Redundancies and complementariness among project participants helped covering a broad spectrum of interests • Existing knowledge and understanding of exploitation amongst the partners • Experienced project partners

		• Well working project management and zealous project partners
	main market-oriented exploitation obstacles	• Diverging levels of technology sometimes hindered know-how transfers • Competitors involved in the project

1.23. INMAR (1)

The project

The consortium consisted of leading research institutions (11 universities, 8 research organisations) in the field of smart structures and intelligent material systems, as well as major industry partners (23 companies), of the intended applications for example Ford, Volvo, VW and Siemens Trans. 8 of which are SMEs, having special competence in the field of materials. The project development was pushed by suppliers, who work closely with automotive OEMs The project was coordinated by the Fraunhofer Gesellschaft (Fraunhofer Institute for Structural Durability and System Reliability LBF) and started in January 2004 for duration of four years.

The objective of the INMAR project was the research and realisation of intelligent, high-performance, adaptive material systems with integrated electronics for different individual applications. Aside from the development of the materials or material systems themselves, this research also included their characterisation, simulation tools for the design process, handling and manufacturing techniques as well as the reliability of these material systems. The project was divided in three complementary technology areas (sub-projects) dealing with intelligent material systems and their integration, simulation, and life-cycle aspects. The main objective of smart structure technology is noise and vibration reduction in civil engineering, machine tools, automobiles, trains, and aerospace engineering. The INMAR project was set-up in such a way, that the scientific and technological objectives are reflected in a structure divided in the two clusters technology area and application scenario. The basic idea of this structure was that the application scenarios focused on the development of active noise reduction concepts for specific 'noise, vibration, and harshness' (NVH) problems and the technology areas provided the required enabling technologies such as the actuator and sensor systems as well as the control strategies and integration techniques.

The main objectives of the application scenarios were to design and develop advanced active noise reduction concepts for exterior noise of automotive and trains, interior noise in automotive, trains and buildings and sound quality of interiors.

Market-oriented exploitation

INMAR was originally designed to produce a fully integrated innovative solution in noise and vibration reduction in civil engineering, machine tools, automobiles, trains, and aerospace engineering. While the research conducted did not produce any major setbacks, the different partners (with their respective sub-tasks and work packages) were developing individual approaches to commercialising the research outcome along the three main technological areas included in the project. Another step of importance for the market-oriented exploitation of the project was that a major share of the consortium partners started to focus on the development of their own line of products. As each of these partners, Smart Materials – who were responsible for developing a new material – analysed the economic potential for themselves. Although technically feasible and developed according to agreed technical standards, the material developed during the INMAR project was not yet commercially viable. Cost considerations are highly relevant, not just in the automotive sector, when it comes to deciding whether a technical innovation should be taken to market.

Consequently, Smart Materials had to transform a high-performance, high-cost material into a product closer to the reality of their customers’ purchasing rationales, which are predominantly driven by costs. Thus, the next step in the transformation of the research outcome into a marketable innovation was to rather improve already existing products based on the knowledge created during INMAR and address niche markets where the purchasing rationale is more driven by performance than cost issues with the material developed instead of mass markets as originally intended. Therefore, the company was ultimately able to enter new market segments with their newly developed products and services. A final step after focussing on niche markets was to use the customer experience from these niche markets to (re-) introduce the material developed to mass market customers. As the performance was now proven, the cost reasoning of the initially addressed customers became less relevant (or the cost-benefit-ration assessment changed in favour of Smart Materials). Today, the company is now selling their materials and know-how in noise reduction concepts to large-scale customers in aerospace and related industries, too.

LESSONS LEARNT

For INMAR’s Smart Materials the key to a successful market-oriented exploitation (as for many of the project partners) lay in the early awareness of the fact that a fully integrated solution might not be marketable for a number of reasons. This awareness was successfully translated into exploitation strategies on a smaller scale, i.e. limited technological innovativeness and niche markets. Smart Materials used their experience in these niche markets to successfully introduce their product to larger markets and customers because at that point they were able to refer to customers using this material, which in turn changed the cost-benefit-assessment of their initially addressed customers and markets.

FACT SHEET

	type of information	information
project	project title acronym	InMAR
	FP	6
	thematic area/priority	NMP4
	instrument/type of action	IP
	number of partners	42
	main project outcome	Noise and Smart Structure Technologies
case study	product, technology, service that was/is going to be commercialised	piezo sensor for noise reduction (Macro Fiber Composite)
	main commercialising organisation	Smart Materials GmbH a German-based SME developing and manufacturing advanced piezo-composite materials and systems based on these materials
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	Global
	target market (sector)	A wide range, including sports, medical applications, automotive, aerospace and related industries.
	state of market-oriented exploitation	Available
	main story steps	• The project was divided in three complementary technology areas; • Development was pushed by systems suppliers, who delivers to the OEM; • The SME produced sensors which were tested for commercial use; • Project came to a halt due to cost/benefit considerations. • Partners started to develop their own separate (sub)-projects. • SME’s (existing) products and services were improved; • New markets were entered, and new collaborations were established;
	type of pathway	indirect commercial transformation
	main market-oriented exploitation success factors	• Well working know-how transfer in-house and between partners • Internet as main channel for contact and sale • Small range of new products and services were developed using InMAR knowledge • Partners across the entire value chain in the consortium

	main market-oriented exploitation obstacles	• Commercial market not ready for original product: Costs and (currently low) customer value as crucial factors; • Market requirements change rapidly • Operating in a pull market: Being a supplier in the value creation chain, the company is not in the position to push developments; • Too small to develop own products; • Most consortium partners focused on developing their own line of products • Some minor parts of the project goals could not be realised;
	other supportive factors	• Concept potentially attractive for new market segments

1.24. INMAR (2) (LMS INT)

THE PROJECT

The consortium consisted of leading research institutions (11 universities, 8 research organisations) in the field of smart structures and intelligent material systems, as well as major industry partners (23 companies), of the intended applications for example Ford, Volvo, VW and Siemens Trans. 8 of which are SMEs, having special competence in the field of materials. The project development was pushed by suppliers, who work closely with automotive OEMs The project was coordinated by the Fraunhofer Gesellschaft and started in January 2004 for duration of four years.

The objective of the INMAR project was the research and realisation of intelligent, high-performance, adaptive material systems with integrated electronics for different individual applications. Aside from the development of the materials or material systems themselves, this research also included their characterisation, simulation tools for the design process, handling and manufacturing techniques as well as the reliability of these material systems. The project was divided in three complementary technology areas (sub-projects) dealing with intelligent material systems and their integration, simulation, and life-cycle aspects. The main objective of smart structure technology is noise and vibration reduction in civil engineering, machine tools, automobiles, trains, and aerospace engineering. The INMAR project was set-up in such a way, that the scientific and technological objectives are reflected in a structure divided in the two clusters technology area and application scenario. The basic idea of this structure was that the application scenarios focused on the development of active noise reduction concepts for specific 'noise, vibration, and harshness' (NVH) problems and the technology areas provided the required enabling technologies such as the actuator and sensor systems as well as the control strategies and integration techniques.

LMS Int. was involved in the INMAR project and provider of simulation software and services in the field of acoustic measurement optimization. The company operates with partners in automobile, aerospace and other manufacturing industries and provide solutions for evaluation methods in terms of acoustic, vibration, endurance strength, as well as software for mechatronic modelling systems. Even though there were 40 partners in the INMAR project totally, LMS Int. cooperated in their work package of the project with 10 of them.

For LMS the outcome of the project was the development of a methodology and a work flow on how to set up a simulation on mechatronic systems, which is an intangible result. The intention during the project was not to create new closed, unique software out of the project, but to upgrade to existing software and develop additional commercially exploitable software packages.

MARKET-ORIENTED EXPLOITATION

The moment when LMS started to think about market-oriented exploitation was 6 months before the project ended when they successfully demonstrated and applied the methodology in a large-scale laboratory case study, which was more or less representative for industry and thus, already indicated the commercial potential. Arranging the demonstration was not problematic, because the partners worked well together, had a good understanding and a common goal. However, technically, it was a challenge. The demonstration succeeded and several publications both in academic and industry magazines resulted from it. Their most important dissemination papers were based on this demonstration.

During the research and after the demonstration, they found that there were still several technical and fundamental challenges to be solved which went beyond the scope of the INMAR project. These challenges were partly investigated in a parallel project running simultaneously from the second half of the INMAR project called SMART Structures that lasted 2 more years.

The methodology in itself was incorporated through an assembly of software tools and the knowledge on how to use and sequence the consecutive use of these tools. These methodologies are being implemented in commercial tools and in the in-house simulation tools. Simulation plays an important role in the development of quality products ensuring that the proper product performances will be achieved without the need to make and iterate costly physical prototypes. This simulation process is complex, involving a number of steps: Describing the problem, building the model, making a prediction on how the product performance (e.g. the noise level) will be and then optimize the design to achieve the required specifications. In modern car manufacturing process, companies rely a lot on simulations to achieve superior product quality and consequently, LMS sells simulation software to them. As of today there are however no simulation software for building intelligent vehicle solutions. Through INMAR and follow up projects at national levels they have been working on this.

With regard to the scope of commercial success provided achieved with the transformed INMAR result, LMS had to face the fact that the market for the applications of advanced noise reduction tools is a difficult market. In order to maximise the positive economic effects of the research conducted in INMAR and its follow-up projects, LMS needed to explore other markets. By tapping into the market knowledge of their customers they learned that the same methodology was fully applicable to other problems in the vehicle industry. They found out that there was a very big interest in fields of suspension of the vehicles for safety, for comfort and that there was a concrete market need.

While LMS do not have a complete solution yet, they have some new software modules that can be applied in that field and they do consulting services in that field. So while the original goal of the active noise control is not something that they sell on a large scale, the knowledge of working with control systems (based on modelling active systems) allowed them to enter another field – that of suspensions, ABS breaking systems, stability control, vehicle stability – where the economic success is actually much bigger than they could have expected from their original plans. They have now adapted and new software tools in this new field, where they continue to build knowledge and partnerships. LMS have developed software for simulating vehicle road behaviour which can work together with existing control software of the customers. Consequently they have adapted and made better software tools that allow simulating intelligent suspensions in vehicles. They are selling these under the generic name: 'co-simulation' tools. This appeared to be one of the most important steps for LMS in market-oriented exploitation of the methodology.

LESSONS LEARNT

LMS and their market-oriented exploitation particularly highlight two main lessons: the unpredictability of research (or, more precisely, the difficulty to fully foresee the economic value of an – for most of a R&D project's duration – unpredictable outcome) and the crucial relevance of market knowledge. LMS actively transferred the knowledge produced to an application area, which they originally did not have in mind. Their strong links to their customers and extensive market knowledge enabled them to identify another potential market, which ultimately allowed them to create return-on-investment that otherwise would have been unachievable. Building extensive market knowledge, keeping close ties to (potential) customers and being able to flexibly act upon this changing market knowledge, even if it means to abandon or deviate from an existing strategy, proved to be key elements of this case study.

FACT SHEET

	type of information	information
project	project title acronym	InMAR
	FP	6
	thematic area/priority	New generation of sensors, actuators and systems for health, safety and security of people and environment
	instrument/type of action	Integrated Project
	number of partners	42
	main project outcome	Development of the materials or material systems. A significant progress towards the proof of feasibility, the build-up of samples and systems as well as on their characterization was achieved.
case study	product, technology, service that was/is going to be commercialised	A methodology to set up the simulation and design optimisation of mechatronic systems
	main commercialising organisation	LMS Germany (LMS International) a company developing and offering virtual simulation software, testing systems, and engineering services
	target market (region)	Global
	target market (sector)	Automobile manufacturing, intelligent vehicle solutions (suspension of the vehicles for safety)
	state of market-oriented exploitation	Further development of the methodology, market oriented
	type of pathway	direct commercial transformation including additional research activities
	main story steps	• It was not the intention to create closed, unique software out of this research, but it was about upgrading the existing software and developing additional software packages and sell these as a software portfolio on the market. • During the research and after the demonstration, they found that there were still several technical and fundamental challenges to be solved which went beyond the scope of the INMAR project. These challenges were partly investigated in a parallel project running simultaneously from the second half of the INMAR project. It was called SMART Structures, a Marie Curie project, where a part of the team from the INMAR project was involved to further develop the basic knowledge • The moment when they started to think about market-oriented exploitation was 6 months before the project end, when they managed to make a demonstration and apply the methodology to a very large laboratory case study which was more or less representative for industry. • The next step that is needed is further developing the methodology, completing the missing part of it, in order to turn them into commercial tools. The necessary product integration step to transform the results into a commercial software version represents quite an additional investment.

	main market-oriented exploitation success factors	• "Inclusion of the entire value-chain • Involvement of large industry companies which are also the end-users • Involvement of the SMEs"
	main market-oriented exploitation obstacles	• Difficult market (interest from the industry, market readiness)

1.25. NANOBIOPHARMACEUTICS

The project

The NANOBIOPHARMACEUTICS project aimed at the development of innovative multidisciplinary approaches for the design, synthesis and evaluation of molecular nanoscale and microscale functionalities for the targeted delivery of therapeutic peptides and proteins. The project combined 27 (25) partners of which 3 were large pharmaceutical companies and 4 (originally 6 but one was re-integrated into its parent company and another one went bankrupt during the project duration) academic spin-offs; the large companies involved are actual competitors. The academic cooperation was based on personal contacts and the professors also included some of their spin-offs (SMEs in the project)

The project focused on the development of functionalised nanocarriers for the treatment of various diseases based on targeted, controlled delivery of protein-peptide (P/P) drugs.

The undertaken activities were organised in various distinct, yet interrelated, Work packages (WPs) which analysed the following project components:

- Design, synthesis and functionalisation of novel "nanocarriers" and nanoparticle-based "microcarriers" for the targeted delivery of protein and peptide drugs through the oral or pulmonary route or the blood-brain barrier.
- Toxicological screening of "nanocarriers" and investigation of the release profile of protein and peptide drugs under different environmental conditions and assessment of the biocompatibility and biodegradability of new drug formulations.
- New pulmonary delivery systems for improved transport of protein and peptide drugs to the lung.
- New oral delivery systems with protective properties which adhere to the gastrointestinal mucosa and increase permeation.
- Development of an in-vitro model for assessing the permeability of "nanocarriers" and in-vivo analysis of drug transport through the blood-brain barrier.

The predefined objectives and milestones of NANOBIOPHARMACEUTICS were successfully met in full accordance with the work plan, the consortium agreement and all ethical guidelines. The project was successful in terms of producing, testing and implementing numerous nanoparticulate carrier systems. These systems, combined with peptides, were the basis for in vitro and in vivo tests addressing the oral, nasal and BBB administrative routes.

For the oral administrative route, a real breakthrough was achieved and a patent was filed. For the nasal and BBB routes very promising systems were developed, which were anticipated to form the basis for further developments in order to establish systems which might also be used in clinical testing. In addition to these application oriented developments, a deep understanding of possible interactions of the nanocarriers with cell systems was generated.

The acquired knowledge was successfully disseminated through several paths. Firstly, a project website was created and continuously updated. Moreover, several scientific publications were produced and two conferences were organised as part of the project. In addition, team members were invited to present the project progress in various events, while training activities on different topics were provided by the consortium.

Market-oriented exploitation

The commercial application idea behind the project was developed some 4 years before the development of the project proposal. The proposal had to be submitted twice in different versions for EU funding before being approved (the second version included substantial changes). It was submitted for EU funding because there was a pharmaceutics-related call opening a realistic chance for funding.

When forming the consortium the challenge with regard to the expected commercially valuable outcomes was to include large companies that would secure the industrial application of the outcome while they are competitors at the same time. The definition and delineation of the work packages proved to be crucial in this regard. Apart from organising the project in separate work packages the coordinator also had to develop respective agreements regarding IPR etc. The commercial interests of (at least) the large companies involved were clear from the beginning, which made it possible for the coordinator to act accordingly, which consequently ensured the large companies' active participation throughout the project.

Large companies often begin commercialising (i.e. developing into an industrial application, which in pharmaceuticals does not mean that an actual product is foreseeable due to clinical trials etc.) research outcome already during the research stage by taking different (interim) results from of the project and shifting the respective further development to company. By enabling and "allowing" the large companies to do this (which included actively hiring employees of project partners), the coordinator created confidence and trust, and made sure these companies used their own resources for additional work (such as testing) and fed these results back into to actual project at least partially.

A constant refinement of the projects' strategy and structure (e.g. synthesis work packages were merged to increase efficiency and finally disintegrated) is very much a "natural" process but it was highly important that such changes were largely industry-driven as their interest in applications was the driver behind the project.

At one point in the project, one of 3 potential main applications (basically along 3 different ways of applying the nano-couriers including the API) became discredited due to a (non-related) study that produced indications of potential carcinogenicity that were mistakenly ascribed to the application methodology and not the API used in the study; as a result the application was "burned" for the industry (as it was now publicly linked to cancer) and therefore the consortium followed what in the beginning was thought to be a sideline of development – the academic partners would have continued with the original main-stream application but industry partners prevailed.

All in all, the large companies involved very much shaped and controlled the work packages' content and focus. Its commercial value was also increased through the attention the project attracted, both publicly (the "interested" public) and from the

Commission up to a point where the Commission actively intervened in the research by “suggesting” the inclusion of an HIV-related research issue.

There were several commercially valuable results were several: a platform technology combining nano-couriers and API (these two were also results of the project), a data base of areas of application for different nano-couriers and the respective modes of action, a completely new methodology for applying nano-couriers and API (a nano-gum, developed and patented by an academic project partner), which was a sideline development, and several patents for different partners (SME and large companies). The consortium continues to cooperate in varying combinations of partners and the project was continued in FP 7 with parts of the consortium.

As most of the commercially relevant research outcomes were object to mandatory testing, the market launch of its industrial applications is still pending (primarily due to the length of the clinical trial period). However, the scope and relevance of testing produced an already successfully marketed research outcome: a testing strategy for toxicological analysis.

Lessons learnt

When forming the consortium the challenge was to include large companies that would secure the industrial application of the outcome while they are competitors at the same time; the definition and delineation of separate work packages were crucial. By implementing complex IPR agreements and separate work packages, the project coordinator managed to incorporate the interest of especially the large pharmaceutical companies in the market-oriented exploitation of the research outcome, which was clear from the beginning, and ensured their activity and engagement throughout the project. Basically, the commercially relevance of the project was safeguarded by allowing the large companies involved to shape and control the work packages’ content and focus.

Fact sheet

	type of information	information
project	project title acronym	NANOBIOPHARMACEUTICS
	FP	6
	thematic area/priority	NMP1
	instrument/type of action	IP
	number of partners	27
	main project outcome	nanocouriers for API (biopharmaceutics)

market-oriented exploitation case study	products, technologies, services commercially exploited	• nanocouriers for API • new API • data base of areas of application for different nano-couriers • a nano-gum • technology platform for the combination of nanocouriers and API
	main commercialising organisation	Lek Pharmaceuticals (Sandoz), GlaxoSmithKline, Novo Nordisk (multinational pharmaceutical companies)
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	global
	target market (sector)	pharmaceuticals
	state of market-oriented exploitation	clinical trial stage
	type of pathway	direct commercial transformation including additional research activities
	market-oriented exploitation process	• the project (or more precisely, the idea behind the project) was submitted twice in different versions (less focussed etc.) for EU funding before the actual successful proposal (i.e. the process of submission and rejection produced substantial changes) • there was a pharmaceutics-related call that allowed the consortium another try • forming a consortium that included two (later: three) multinational pharmaceutical companies was a complex process but was ultimately successful • due to the involvement of high-ranking industry partners the development of the necessary consortium and IPR agreements was a crucial stepping stone for the project • the structure of the project and its working packages had to be changed actively by the consortium leader according to changes in the research process and progress

		• one of the potential market-oriented exploitation paths had to be abandoned due to public (mis-)conception • animal experiments went wrong and additional research had to be conducted (identifying the reasons) but created a testing strategy for toxicological analysis that is now commercially offered by the consortium leader • overall outcome of the project: a platform technology, a data base (of application possibilities), 3 new technologies (to apply API, new API, the toxicological analysis strategy, several patents and a number of results included in the industry partners' on-going research • "core" results are currently still in the clinical trial stage • continuation of the cooperation and joint proposal in FP7
	main market-oriented exploitation success factors	• managing coordinator with technical background and professionalised project management • level of activity and engagement of industrial partners • early and extensive incorporation of the Commission's scientific officer in order to safeguard support for changes in the project and dissemination aspects • strongly entrepreneurial academic partners
	main market-oriented exploitation obstacles	• some of the SME partners were inactive (free-riding) • manufacturing SME partner went bankrupt

1.26. NEWBONE (ConMed)

The project

NEWBONE was an Integrated Project with a consortium consisted of 12 high tech companies and four universities. The major aim of NEWBONE project was to develop materials for surgical bone repair and replacement where load-bearing and ligament fixation capabilities are essential. NEWBONE project has developed fibre and nanohybrid reinforced composite (FRC and NHRC) materials for surgical bone repair and replacement where load-bearing and ligament fixation capabilities are essential. The proposal was high-tech SME driven.

The project was expected to have significant impact on the quality of life of patients with a hip stem or knee implant combined with minimised risk of complications and costs. Furthermore, the respective surgical procedures were expected to be less invasive leading to significant shorter treatment times.

The partners in this project consortium included the Swiss company Medacta, a producer and marketer of hip and knee prosthesis and the Finnish company ConMed Linvatec Biomaterials Ltd, part of a global medical sector company and a producer and marketer of sports injury repair systems. Medacta is committed to develop FRC load bearing bone implants. The initial idea behind of this project was to create special-type materials based on fiber glass, but being non-resorbable. The research was to come from metals to composites.

The results of the project were expected to cover the gaps that existed in Europe in terms of increased health care costs and decreased quality of life of the patients involved in bone replacement operations as well as in terms of Europe dragging behind United States in the commercialisation of biomaterials and implant technologies. Surgical procedures involving bone and joint replacements are increasing in a linear way, especially in Europe due to aging population. Also the average age of the users of implants is decreasing and thus the load-bearing requirements for implants are getting tougher. In the medical sector, biomaterials is one of the fastest growing sectors reflecting the continuously increased demand for joint replacements and spinal surgery and the exponential increase of osteoporotic fractures. The Unites States is the world market leader in the field. Many of the implant and biomaterials technologies have been invented in Europe but the commercialisation has been lost to outside Europe.

Market-oriented exploitation

ConMed is committed to develop sports medicine implants from the NHRC composite material developed in the project. In the end of 2009, ConMed commercialised the ACL interference screw line based on NHRC material developed in the NEWBONE project. This product line includes the world's smallest composite ACL interference screw, namely 5.0 mm. In this way the NHRC part of the project was fully commercialised.

The ConMed's patent regarding material in scope was already filed when the project started. The patent application was not very specific; the project aim was in fact to obtain a more suitable material for implants production. The case was that the initial composite was already available, but its properties and manufacturing were not suitable for market introduction. The purpose was to obtain a material being stronger and easier to produce. Due to such IPR approach, the final product obtained within the project is in fact also protected with the original patent.

Even if no patentable results were created by NEWBONE project with FRC orthopaedic applications, the long-term FRC-material research lead by Professor Pekka Vallittu since 2000 in a great cooperation between the University of Turku and the Turku University Hospital has recently realised an industrial project (in year 2012) funded by Tekes (national funding agency, EU Contact Point).

The part of the project led by Medacta is reported to require more research about the product developed. So far there is no additional funding granted by the Commission to continue with this part of project. As mentioned above there is a continuation of different efforts undertaken by former partners. The Newbone as a project was focused only on orthopedic implants (due to partners' focus on orthopedic applications). Therefore application efforts are currently continued into other less 'bearing' areas.

Both Medacta and ConMed are committed to the further development of the FRC and NHRC material based implants to be included to their future product portfolios. With their existing marketing organisations having a good global coverage, the project results have immediate potential to be commercialised worldwide

Additionally to main stream project results a couple of publications were coming out, resulting from the new developed material, including also some master's thesis developed at the engaged universities. The doctoral studies associated to the project were rather of general nature, not directly connected to the final product developed in ConMed.

Overall, the NEWBONE effects were in fact delivered with much bigger engagement of ConMed than the overall declared budget of the project, still the effort made regarding this new material gives a very positive impact: the company is selling its interference screw with around 20,000 pieces a year – and ankle element with a quantity of around 5,000 a year. Several lines of products based on this material were already developed and more applications and new ideas are coming.

LESSONS LEARNT

The foundation for it's the project's successful market-oriented exploitation was laid by ensuring mutual trust among all project partners, which was achieved through letting the project's design and implementation reflect the commercial interest of companies involved. This was additionally supported by a professional project management.

Another important lesson confirms the importance of having entire value chain represented in the project. In this case such structures were concentrated in one global network assured by ConMed, and leading to full commercialisation. The company brought into the project research facilities, IP and knowledge, existing large scale production capabilities, experienced testing environment and legal services, distribution and marketing system, established globally. These structures were able to put the product directly to the market, dealing with all necessary certifications and safety procedures, required in the medical applications.

FACT SHEET

	type of information	information
project	project title acronym	NEWBONE
	FP	6
	thematic area/priority	NMP2
	instrument/type of action	IP
	number of partners	16 (4 universities)
	main project outcome	Technology implemented in several products
case study	product, technology, service that was/is going to be commercialised	Fibre and nanohybrid reinforced composite (FRC and NHRC) material for surgical bone repair and replacement where load-bearing and ligament fixation capabilities are essential.
	main commercialising organisation	ConMed Linvatec Biomaterials a Finnish SME
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	Global
	target market (sector)	Medical
	state of market-oriented exploitation	A portfolio of products based on the developed material was made available on the market via ConMed Linvatec Biomaterials
	type of pathway	direct commercial transformation including additional research activities
	main story steps	• Development of the proper implant material (FRC) and matrix formation. Biomechanical assessment. • Adaptation of the surface properties (porosity, addition of bioactive fibers and/ or coatings, functionalisation etc.) • Characterisation and testing of the structure developed. • Formulation and adaptation of all processing, manufacturing issues. • Standardisation and market-oriented exploitation of the final product. Training of end-users.
	main market-oriented exploitation success factors	• Detailed planning, defining clear roles for all partners • Efficient and experienced project coordination is crucial for project success. • Assuring good spirit and a high level of trust • Project focus in general must be in line with participant interests. • The right time approach to regulatory issues. • Experience on regulatory issues in the health sector.

		• Consortia created for European project are considered very effective for future networking and new follow-up and related research projects.
	main market-oriented exploitation obstacles	• The second project line (non-resorbable bone fixation) did not get any final product to the market, yet although the research results were produced. The material efficiency and regulatory issues influenced here the market implementation of products. • Co-existence of competitors in EU financed project would be considered as a huge obstacle in general.

1.27. SINPHONIA (SCONTEL)

The project

The goal of 'Single-photon nanostructured detectors for advanced optical applications' (Sinphonia) was to develop and investigate a specific type of single-photon detector based on superconductor nanostructures, and demonstrate its use in a number of applications requiring ultimate sensitivity in the near-infrared (IR) and high speed of operation. These superconducting single-photon detectors (SSPDs), demonstrated for the first time by one of Sinphonia's partners, rely on the formation of a resistive 'hot spot' in a superconducting nanostripe upon absorption of a single photon, and on the consequent generation of a voltage pulse.

The consortium involved 9 partners, mostly universities and research institutes.

The goals pursued in the SINPHONIA were:

- Fabricate single-photon optical detectors with unprecedented performance at telecom wavelengths (four orders of magnitude more sensitive and three orders of magnitude faster than commercially-available avalanche photodiodes and photomultipliers).
- Demonstrate their implementation in several IST applications by industrial partners.

The idea was to create a spin-off from the Moscow State Pedagogical University (MSPU) which together with the university would participate in the project. The consortium was also based on an agreement that the partners would buy the product that followed to be developed in SINPHONIA. For the spin-off company the project provided valuable knowledge about the needs of the customers and the indications about the market for such a device.

The first step in the process was the acquisition of the cryogenic equipment by the MSPU which was shared among the partners and was crucial for the development of the SSPD. The spin-off company had grown due to the possibility to manufacture and commercialise the SSPD. Thereafter, licensing agreement with the University for using the processing equipment (for SSPD chip fabrication) was set up for the spin-off.

The device was further developed through integration of electronic and cryogenic components. Partners finished this part after the end of the project, in 2009. By the project’s end a pre-product was available. The partners were also heavily engaged in testing the device and providing feedback on how it functions and how it could be improved.

Market-oriented exploitation

Sinphonia has pushed the technology of ultrathin superconducting films much beyond the state-of the- art. Overall, the Sinphonia consortium defined the state-of-the-art for the device performance in terms of sensitivity and speed, for the device functionality and for applications.

A first commercial solution is already available from a spin-off of a Sinphonia partner, and has found initial acceptance in the instrumentation market. Future plans include the development of Sinphonia's technical breakthroughs as commercial products, and extending the market share by the development of more advanced system solutions including cryogen-free cooling. The vigorous research activities deployed during the project will continue in Sinphonia and other laboratories and will contribute to the further development of this exciting research and application field.

Lessons learnt

During the project lifetime, and in large part due to the partners' efforts, SSPDs have evolved from a technological curiosity to an established technology, widely recognised as the key approach to ultrasensitive single-photon measurements. The Sinphonia consortium has identified different areas of applications where SSPDs can find use. On one hand, the optical instrumentation market represents already today an interesting, small-volume market for SSPDs. On the other hand, quantum key distribution, remote sensing, picosecond integrated circuit analysis and optical communication can open up larger markets in the medium term. Hence, both pre-defined objectives are considered fulfilled.

It showed that countries (the US, Japan, China) have considerably different requirements compared with Europe. An issue resulting out of this was that the device had to be 'tailor-made' for each customer and laboratory, regardless country, which implied that they could not have mass-production of the device. This also implied issues of training the internal staff in the company to learn to adjust the devices to specific needs of the customers and solve the different labs' difficulties connected to the device.

Fact sheet

	type of information	information
project	project title acronym	SINPHONIA
	FP	6
	thematic area/priority	NMP3
	instrument/type of action	STP
	number of partners	9
	main project outcome	Optical sensor technology

case study	product, technology, service that was/is going to be commercialised	Single-photon optical detectors; knowledge, technical services
	main commercialising organisation	SCONTEL a Russian spin-off from the Moscow State Pedagogical University (MSPU) developing and manufacturing cryogenically cooled devices based on thin film superconducting nanostructures
	if market-oriented exploitation is done in cooperation: composition of the market-oriented exploitation consortium	-
	target market (region)	European
	target market (sector)	Instrumentation market: research labs (universities, research institutes, research centres of large industrial companies
	state of market-oriented exploitation	Product available on the market. A first commercial solution is already available from a spin-off of a Sinphonia partner, and has found initial acceptance in the instrumentation market. Future plans include the development of Sinphonia's technical breakthroughs as commercial products and extending the market share by the development of more advanced system solutions including cryogen-free cooling.
	type of pathway	direct commercial transformation including additional non-research activities
	main story steps	• setting up the licensing agreement with the University for using the processing equipment (for SSPD chip fabrication), • During the two first years the effort was put into testing and characterization of the device and learning the manufacturing steps of the device. • The next step was compared with taking the leap from the chip to the system, • The device was further developed through integration of electronic and cryogenic components

		• The partners were also heavily engaged in testing the device and providing feedback on how it functions and how it could be improved. It was emphasized that the partners’ feedback was crucial for learning the customers’ needs and specifications for the product.
	main market-oriented exploitation success factors	• Highly qualified professionals; • Committed industry (they bought the pre-product, tested it and contributed to its further development); • Involvement of end-users (their knowledge and dedication was crucial) • Researcher's entrepreneurial background • The technology was core for all the partners • Agreement on market-oriented exploitation strategy from the beginning
	main market-oriented exploitation obstacles	• Difficulties for making a cost-benefit and pricing the new product when it is not existing in the market. • Different requirements and characteristics of laboratories in the different countries.

ANNEX

1.28. LITERATURE

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1.29. INTERVIEW GUIDELINES

overall task / question	Please describe ("story telling") the chronological course of events and actions leading from composing a research consortium for FP4/5/6 funding to a successful commercialisation (NOT or at least only marginally aspects of commercial success)!	
1. R&D		
1.1 composition of R&D consortium		
1.1.1 basic characteristics		
impact factor	***impact***	***questions***
few partners in a R&D project	will likely increase the chances for successful commercialisation	How many partners were involved in the project? What was the overall experience with the respective number of partners regarding research and commercialisation processes (strategy and agreements)? Do you think the size of your consortium in FPX (and Y) had any effects upon your technology (name of the technology) reaching the market? If 'yes', then why? If 'no', then also why? Did the size of the consortium have an impact on the coordination processes and costs?
companies in the consortium represent the value-chain and all roles present: developers, implementers, end-users	will likely increase the chances for successful commercialisation	With regard to the product developed out of the research outcome: did the research (industry) partners represent the value chain as a whole? Did the project consortium have active members representing the entire value chain, especially implementers of the technology? Involvement of customers and/or end-users in the project? How were the needs of end-users/customers analysed and benefits for them identified and quantified? If yes, what effects has this had on the aims and the process of commercialisation of the technology? If no, what were the effects in this regard?
Presence of an exploitation strategy expert partner	will likely increase the chances for successful commercialisation	Were there one or more active partners involved in the research consortium, who had a particular exploitation strategy (or innovation management) know-how or whose role explicitly covered the commercialisation of the expected research outcome?

1.1.2 industry participation		
impact factor	***impact***	***questions***
participation of large companies in R&D projects as actually interested implementers and end-users	will ensure the project's orientation towards the market and hence facilitate the commercialisation	What was the role of the large companies involved with regard to the commercial focus of the project and the commercialisation processes (driver, constraining etc.)? Were they committed to exploitation?
dominance of SME in an R&D project	will complicate commercialisation due to the limitation of resources typical to SME	What were the effects of the dominance of SME in the research consortium (if there were any)? How did you cope with that?
dominance of academic spin-offs or high-tech SME	will outweigh the SME domination effect (or in fact boost commercialisation success)	What were the effects of the participation of spin-offs and high-tech SME in the research consortium (if there were any)? How did you cope with that?
if leading companies are involved in R&D projects	knowledge transfer and commercialisation success increases	What was the role of the leading company/ies involved in the research project with regard to the commercial focus of the project and the commercialisation (driver, constraining etc.)?
the technology development is being pushed or driven by one or more of the partners	will likely increase the chances for successful exploitation	Has the technology developed been pushed or driven (in the project and in general) by one or more of the consortium members? Who of the partners were pushing or driving the technology towards the market? How did they do that? Were there organisations outside the consortium that drove the technology development? How did the consortium deal with their "absence"? What was the role of these organisations regarding the focus of the project and its commercialisation, what was the respective effect?
technology under development is the core of the exploiting partners' activities	will likely increase the chances for successful commercialisation	Was (or is) the technology (or technological "field") a core technology for one or more of the research partners? How did this affect the project as such and the commercialisation of technology?

1.1.3 participants behaviour		
impact factor	***impact***	***questions***
actual commitment, core interest and respective behaviour of R&D and/or industrial project participants (=active participants)	will ensure the project's orientation towards the market and hence facilitate the commercialisation	How active were the different partners with regard to both the project as such and the (potential) commercialisation? Can one or more of the partners be considered rather "sleeping" than active? What were the effects of the respective constellation (e.g. with regard to choosing partners for the commercialisation)?
opportunistic behaviour by implementing partners	will have a negative effect on commercialisation	Did any critical industrial partner appear to be opportunistic and perhaps free-riding?

1.2 organisation and management of R&D projects and/or processes		
1.2.1 open innovation		
impact factor	***impact***	***questions***
organising R&D as "open innovation" for enabling or platform technologies (outside-in)	will increase knowledge base, market orientation and commercialisation success	Did your institution/company use elements of open innovation, e.g. accessing expertise, know-how from other organisations (e.g. customers, other companies) outside "classic" collaborative research projects? What kind of expertise? Is this a routine? What were the effects (e.g. commercialisation took longer, learning was increased, commercialisation was rather indirect result etc.)? Does your institution/company (continuously) screen the research done by others? Is there a difference between the organisational level and the project as such (e.g. only one of the two following open innovation principles)?
being open to grant others access to IP portfolio (inside-out)	will increase commercialisation success of unused IP	Did your institution/company strategically grant access to its IP portfolio to other organisations and vice versa? Does your institution/company buy others´ IP? Does your organisation grant access to its own IP if they cannot be commercialised (at least partially) internally?
outsourcing of and cooperating in commercialisation if it cannot be done internally (inside-out)	increases likelihood of success	Which organisation managed the commercialisation (i.e. your organisation, joint effort with one or more partners or exclusively by another organisation)? (How) were they involved in the project during the development of the technology? How would you describe the cooperation (e.g. task-based like in contract research, cooperative, interactive?
1.2.2 previous experience		
impact factor	***impact***	***questions***
frequent engagement in collaborative R&D projects and their successful commercialisation	will increase learning and improve the handling of collaboration (also in commercialisation processes)	Were you involved in collaborative R&D projects (EU funded, national or regional funds) prior to the project in question (with some or all partners from the project discussed)? What were the effects of having cooperated before (in general and, if applicable, with some or all project partners)? Lock-in effects when projects partners are very experienced in cooperating with one another?

1.2.3 management and governance

impact factor	*impact*	*questions*
quality of governance processes	strategic intelligence and adaptive/flexible implementation increases the probability of identifying less attractive directions of research and steering the research to more commercially attractive directions	Who managed the research project (a professional project manager?); what were his/her tasks? How was the quality of the management of the EU project? What effects had the management of the project on the commercialization of the technology? Did the governance of the project allow for flexibility and adaption regarding the aims of the project and the commercialisation plans? If yes, describe how.
management decisions take account of exploiting partners' needs	will increase chances of exploitation	Did the project management take account of the needs of those partners interested or (already) engaged in the commercialisation of the research outcome? If no, what were the effects on the commercialisation as such, the composition of a respective group of organisations, the decision how and what to commercialise?
management is well focused on exploitation aims	will increase chances of success	Did management regularly re-focused the project towards exploitation (e.g. by always including such an item in meetings' agendas)?
value chain perspective already included in the R&D stage	will increase the success of commercialisation	Did the project team follow a value chain-perspective during the R&D phase?
continuous monitoring of market and demand	will increase the success of commercialisation	Did the project management include elements of market research/monitoring? How important were these and did actual modifications of the project and its (potential) commercialisation path occur based on such a monitoring?

1.2.4 conceptualisation

impact factor	*impact*	*questions*
confidentiality safeguards are well managed	will increase chances of exploitation	What confidentiality agreements or safeguards were applied for the research project? Did they work well in practice? Was there clear understanding of the dangers of uncontrolled disclosures?
market knowledge, demand taken into account in R&D aims	will increase the success of commercialisation	Did the R&D aims of the project include elements of market knowledge (from the beginning)? How did the consortium safeguard the impact of such knowledge and potential modifications during the project? Who/which organisation brought the respective knowledge? Was the inclusion objective to negotiations or conflicts? In which way were potential end-users or customers for the targeted new products or services involved and/or how were their needs analysed before and/or during the project to ensure acceptance? What methods were used in analysing/understanding the needs of end-users/customers?

type of research (basic vs. applied) and respective time horizon (short- to long-term)	has an effect on the commercialisation time horizon	Was the RD aiming at fulfilling a societal need, regulatory push or market need?
early stage communication and close cooperation of industry with potential financiers	will help to overcome barriers regarding market entry by ensuring access to financial resources	How did you solve the question of attracting financial investments in commercialising your technology at an early stage? Who was responsible for that? When did you find an investor(s)? How did you find your investor(s)? At what time did the project team start to communicate to and/or cooperate with potential financiers?
2. commercialisation strategy		
2.1 aspects strategy		
2.1.1 resources		
impact factor	***impact***	***questions***
exploitation committee is active	will increase chances of exploitation	Did the research consortium have an exploitation committee? Who were they? Did they include potential implementers? If 'yes', how active was this exploitation committee? What was the role and how did it affect the commercialisation?
having management resources for commercialisation	increases likeliness of commercialisation success	Did the partners set aside (sufficient) resources for conceptualising and implementing the commercialisation strategy (including IPR protection)? From the beginning or during the project duration (e.g. if it became clear the commercialisation will be an issue)? Did the project management have sufficient resources? If there were no resources for this allocated in the project, how did you ensure resources for managing the commercialisation of the technology (if commercialised occurred within the consortium)?
existence of commercialisation incentives for employees and managers	increases likeliness of commercialisation success	Did the companies involved have any kind of intra-organisational incentives (e.g. shares of spin-offs, promotion, bonuses etc.) for their staff (management, R&D etc.) linked to successfully commercialising the research outcome (especially for this project, in general)? Did they encourage innovative solutions to problems and/or patenting of such solutions? What effects did this have on the development leading to the commercialisation of the technology?

2.1.2 planning		
impact factor	***impact***	***questions***
having a clear and agreed commercialisation strategy	is the backbone of successful commercialisation	Did the consortium have an agreed commercialisation strategy (from the beginning)? If not, did the (individual) industry partner(s) have their own strategies (Were they disclosed, discussed etc. in the consortium)? Were the underlying exploitation plans rather direct or indirect?
partners had a plan for forming an exploitation group early-on	will increase success rates of (joint) commercialisation and knowledge transfer	Were there plans to form an exploitation group (i.e. parts of the consortium, the consortium as a whole, including or adding external partners) early on in the project? How have these been secured and implemented?
clear technical and exploitation aims of commercialisation, clear vision of expected outcome	increase likeliness of commercialisation success	Did the consortium manage to develop clear commercialisation objectives (with regard to technical specifications and exploitation) and a clear vision of the expected outcome? Were they included in some agreement, strategy etc.?
2.2 IPR		
2.2.1 existing IPR		
impact factor	***impact***	***questions***
existence of overlapping IPR	will minimise the possibilities to apply for patents and complicate if not inhibit commercialisation	Has the project been affected by overlapping IPR (already existing in the technology field)? How did the commercialising organisations cope with that (e.g. ex-ante research into the issue, on-going screening of the patent "landscape" during the project)?
having an overview of the patent "landscape" "Technology watching"	helps to ensure that the patent will be granted and commercialisation will be successful	How did the consortium and/or the commercialising organisations (if different from the consortium) ensure to have an overview of existing IPR in order to avoid problems in securing their (new) IP? Was there a dedicated team carrying out technology watching and reporting finding to partners?
2.2.2 consortium's (new) IPR		
impact factor	***impact***	***questions***
Existence of prior IPR upon which the project is based	will enhance prospects of commercialisation	Was the research project in any way linked to IPR already in "possession" of (some of) the consortium members? What were the respective effects regarding the research, the commercialisation and potentially developed IPR? Did the project's outcome in any way touch IPR not in the "possession" of consortium members (or commercialisation partners)? What were the effects with regard to e.g. necessary licensing agreements (costs), strategic involvement of IPR-holders in the commercialisation (due to their "possession" of relevant IPR) etc.?

clear IPR ownership at the beginning of the project and clear IPR ownership strategy for foreground developed	will enhance prospects of commercialisation	Was the situation regarding IPR ownership clear in the beginning of the research project or the commercialisation stage? Did the consortium have or develop a respective strategy or agreement regarding IPR ownership?
strategic wording of patent claims	will ensure the economic usability of IPR	Did the consortium have access to specialist legal advice regarding IPR management and/or patenting? Did the commercialisation consortium / commercialising organisation access external or in-house IPR-attorneys?"
2.3 partners		
2.3.1 consortium		
impact factor	***impact***	***questions***
commercialisation partners represent different elements of the value chain	increases likeliness of commercialisation success	Did the group of commercialisation partners represent the relevant value chain in all its elements? If the value chain was not already part of the research consortium or it was decided to exclude certain consortium members (and to include other external partners): did the aspect of including the whole value chain constitute a criterion or an issue?
weak or missing exploitation (implementing) partner	hamper commercialisation	Was there any partner in the consortium able to manufacture the prototype and carry out exploitation?
2.3.2 behaviour		
impact factor	***impact***	***questions***
conflicts of interest or interests divergent / not compatible	hamper commercialisation	If conflicts regarding the commercialisation occurred or the interests of the consortium partners were not compatible, how did the consortium and the different members cope with this situation (e.g. look for external partners, decided to commercialise "their" share of the research outcome etc.)? What were the effects on the commercialisation?
partners are risk averse	hamper commercialisation	If the/some consortium members were risk averse regarding aspects of/the commercialisation, how did the consortium and the different members cope with this situation (e.g. look for external partners, decided to commercialise "their" share of the research outcome etc.)? What were the effects on the commercialisation?

partners do not have experience with commercialisation	hamper commercialisation	What experience did the consortium members or the commercialising organisation have regarding commercialisation of research outcome of a collaborative research project? How did this affect the commercialisation of this technology? If the/some consortium members did not have previous experience with the commercialisation of research outcome of a collaborative research project, how did the consortium and the different members cope with this situation (e.g. look for external partners, decided to commercialise "their" share of the research outcome etc.)? What were the effects on the commercialisation?

3. product development

impact factor	***impact***	***questions***
if the cost-benefit ratio of modifying research outcome into a product or applying a technology to production processes is unfavourable	commercialisation will be hampered	During the project, did you monitor the cost-benefit ratio of the technology? Did you carry-out value analysis of the ready technology? How would you overall and retrospectively assess the cost-benefit ratio of the modification of the research outcome into the product/the application technology to the production process?
if the risk-benefit ratio of modifying research outcome into a product or applying a technology to production processes is unfavourable	commercialisation will be hampered	During the project, did you discuss the need for further investments for taking the technology to industry? How would you overall and retrospectively assess the risk-benefit ratio of the modification of the research outcome into the product/the application technology to the production process?
if feasibility and viability of technology is not proven (proof of concept) before product development is attempted	commercialisation will be hampered	Was there a feasibility testing of the technology done? Was the viability proven? At what time?
exploitation partners do not have own funds to cover development costs	commercialisation will be hampered	Did you try to find a funding source or another exploitation partner to take over the industrial development costs? What was the result?

4. market, market research / knowledge

4.1 market / demand

impact factor	***impact***	***questions***
if public's perception is prejudiced (e.g. due to inadequate dissemination towards public)	commercialisation will be hampered	Was/is the technology developed (or the product based on that technology) objective to public debate (e.g. health issues, risk etc.)? How did the organisation cope with that (e.g. awareness or educational measures)? What were the effects?

if there is market pull	commercialisation will be more successful	Was the market ready for your technology? How did you know that? What indicated that the market was ready for the launch of the technology? Were there other market factors that influenced the introduction of the technology to the market?
changing or unsettled demand	will decrease the likelihood of a successful commercialisation	Did you monitor the market/societal needs during the project? Did you develop an alternative strategy?
market is dominated by a monopoly	commercialisation will be hampered	What was the market structure like when the product was launched (e.g. monopolistic)? Did the market structure affect the commercialisation strategy or success? Or more generally, were there (at that time) specific barriers for market entry for new technologies in general or this technology in particular?
market is dominated by vested interests or well entrenched technology	commercialisation will be hampered	Did you try to identify the specific added value offered by the new technology vis-à-vis existing technologies? Did you develop a market penetration strategy? (E.g. niche market first at low profit margin or as a loss-leader etc.)
general economy in a downturn	chances for commercialisation decrease	What was the effect of the overall economic situation on the success of the commercialisation process? Did changes in the market, demand or economic situation affect plans and implementation?
4.2 previous experience		
impact factor	***impact***	***questions***
if academia is lacking entrepreneurial culture and abilities	commercialisation will be less likely	Did the researchers and engineers participating in the development of the technology have previous experience with creating spin-offs or other entrepreneurial activities? Were they interested? Was this possibility discussed during the project? How did this help to the commercialising process?
if organisation was experienced in commercialisation of research outcome	successful commercialisation will be more likely	Was the organisation engaged in commercialisation processes before the one in question? What effect do they assign to this experience on the process in question?
4.3 behaviour		
impact factor	***impact***	***questions***
weak knowledge of the target market by the exploiters	commercialisation will be hampered	How did you ensure expert knowledge on the markets that your technology is targeting? How did the organisation deal with (weak or non-existing) knowledge of the potential target markets (e.g. by including external partners that possessed this kind of knowledge, conducting extensive market research)?

continuous monitoring of market and demand	will increase the success of commercialisation	During the commercialisation stage: did the organisation(s) monitor market developments and have the means to modify their commercialisation strategy accordingly? How important is monitoring markets and demands (in that face of a potentially ground-breaking new product for which there might not be fully developed market or in fact demand)?
4.4 financing / funding		
impact factor	***impact***	***questions***
if the commercialising organisations already had links to VC or in general experience with attracting financers	successful commercialisation will be more likely	Did the organisation have experience with attracting financers to the commercialisation of research outcome and how did this affect the process?
if exploiters are all financially weak or cannot raise funds and the strategy for alternative funding is weak or lacking	chances for commercialisation decrease	Were the organisations prepared to include additional financing partners or in fact did include such organisations? Have such plans been part of the overall strategy? What kind of knowledge of available sources of additional funds was present and is a systematic knowledge crucial for a successful commercialisation (even though such knowledge is only relevant if the situation should present itself as such)?
5. long-term cooperation / cooperation beyond R&D project		
impact factor	***impact***	***questions***
continuation of collaboration beyond the R&D project	will foster the successful commercialisation of the research outcome	Did the organisation continue their collaboration with (at least parts of) the consortium during the commercialisation? Was an exploitation grouping decided before the project? Were license agreements discussed during the project between partners or with outsiders? How did this affect the success?
long-term cooperation	will increase success rates of (joint) commercialisation and knowledge transfer	If the cooperation with research or commercialisation partners is (part of) a long-term collaboration (also prior to the research project in question): how did this affect the commercialisation success? What about potential lock-in effects in unmodified cooperation constellations?

6. technology transfer: if someone else (outside the consortium)commercialises

6.1 characteristics of knowledge

impact factor	***impact***	***questions***
the deeper the knowledge to be transferred is embedded in an organisation	the more difficult the transfer of this knowledge between organisations	How do you assess the knowledge transfer during the process of modifying research outcome into a product or during applying the technology to production processes? Did you experience any difficulties in transferring the knowledge to the different actors involved in the production process and commercialization of technology? Where exactly in the process did you experience difficulties to transfer knowledge about the technology? Why did you have these difficulties? How did you address them?

6.2 characteristics of organisations

impact factor	***impact***	***questions***
the larger the organisational distance	the more difficult the transfer of knowledge between organisations	Did you experience that you had large organisational differences between you and your partners? How did this affect knowledge transfer between you? How did this affect the commercialisation of the technology?
the larger the knowledge distance between organisations	the more difficult the transfer of knowledge between organisations	Did you experience that you had different R&D contexts between you and your partners? How did this affect knowledge transfer between you? How did this affect the commercialisation of the technology?
the more frequent knowledge is being transferred between organisations	the more likely successfully doing so	Were there dedicated and rapid channels for exploitation knowledge transfer from developers to exploiters during the project? How did they affect exploitation?
if regulations, funding mechanisms, incentive schemes etc. favour knowledge transfer	the more likely is successful knowledge transfer	Did you identify any regulations which offer greater motivation (or obstacles) for knowledge transfer? Did you try to benefit from them (or try to reduce their negative influence)?
if R&D is conducted within a cluster	knowledge transfer success will be more likely	Did your collaboration during the technology development and commercialisation take place in a research, industry or high-tech cluster or other forms of institutionalised collaborative network? If 'yes'. Which cluster/network? What effects did this have on the knowledge transfer? What effects did this have on the commercialisation of the technology/the research outcome?

6.3 characteristics of transfer		
impact factor	***impact***	***questions***
if the knowledge to be transferred is not being communicated correctly	knowledge transfer between organisations will likely fail	In what terms was the knowledge about the technology expressed? Did you experience any difficulties in articulating this knowledge? If, yes how did it influence the knowledge transfer between the different partners?
7. meta-hypothesis		
impact factor	***impact***	***questions***
if more than one impact factor applies	-	Which of the above discussed factors (summarize them) do you assess as having been crucial for the commercialisation of your technology? Why? Were there any other factors that have not been discussed above, but were crucial in your case?

1.30. VALIDATION SURVEY

1.30.1. IMPACT FACTORS VALIDATED

The impact and success factors identified during the field work conducted were object to a validation survey, although at a preliminary stage. In sum, 138 individuals' responses from all projects funded under Framework Programmes 4-6 in industrial technologies were used for the analyses. In the following, the main results of this survey will presented and discussed.

The flexibility and responsiveness of SMEs as an essential factor of safeguarding the market-oriented exploitation of research outcome achieved the highest acceptance of the statements regarding the involvement of industrial partners in EU-funded R&D projects in industrial technologies. 35 % of the respondents stated they would highly agree and 52 % they basically agree to this. More than 80 % agreed of which 28 % stated full agreement to the conclusion that the ability of SMEs' to act as links between research and industrial large-scale application is a success factor for the market-oriented exploitation processes. The chance of SMEs becoming an obstacle in the exploitation process because of their limited resources and higher risk of economic failure was dismissed by the majority of respondents (25 % fully disagreed and 35 % basically disagreed). Nevertheless, 40 % approved of this statement.

About one quarter of the respondents (27 %) agreed to the participation of large enterprises as positively affecting the market-oriented exploitation under the condition that these enterprises are actively driving the R&D project (an additional 50 % basically agreed). Under the condition of being also the driver of the technology with respect to the field of application associated with the R&D project, the participation of large enterprises is perceived as less positive for the success of market-oriented exploitation: 23 % fully agreed to such a positive correlation while 19 % basically or fully disagreed.

The analysis produced some additional information about the perception (self and others) of the positive impact of companies in R&D projects and their market-oriented exploitation processes. SMEs are quite confident regarding their own positive impacts on the market-oriented exploitation of research outcome, while respondents from large enterprises and higher education institutions seem to be much more critical. In general, SMEs evaluate their own role in successful market-oriented exploitation process much more positive than the role of large enterprises and vice versa.

The following section focuses on the different impacts of several value-chain-related elements on successful market-oriented exploitations of research outcome, i.e. the participation of industrial partners in general, technology implementers / integrators, end-user, the value chain as a whole, and the involvement of competitors. Again, there is general consent to be observed with one exception: the involvement of competitors.

The involvement of industrial partners at large in R&D projects achieved the highest approval of all value-chain-related composition statements. More than 50 % of the respondents fully agreed to their participation being a key element of successful commercial exploitation; 39 % basically agreed and less than 10 % disagreed. The involvement of potential end-users in R&D projects as a key element of successful market-oriented exploitation received comparable levels of agreement: 53 % fully agreed and 41 % basically agreed. Half of the respondents fully agreed to the statement, that the involvement of the entire industrial value chain increases the likelihood of a successful market-oriented exploitation, and another 40 % basically agreed. A total of 94 % of the respondents agreed to the positive effects triggered by technology implementers as participants in R&D projects.

In contrast, the issue of a decreasing likelihood of successful market-oriented exploitation due to competitors being involved in a R&D project has been widely dismissed: only 19 % of the respondents fully agreed to the negative impact of competitive organisations. However, taking both variations of agreement in account, there is still a narrow majority that supports the statement. Apparently, research organisations and large enterprises value the potentially negative effect higher than SMEs or HEIs.

Considering the effects of prior experiences with R&D projects (and their market-oriented exploitation), the questionnaire differentiated between the positive impact of prior successful exploitation of research outcomes and of prior participation in collaborative research in general. Both impacts factors are widely agreed to as being major elements of success in market-oriented exploitation: 95 % of the respondents at least basically agreed to the positive impact of prior experiences (more than 50 % fully agreed). Prior experiences with collaborative research is (in comparison) least relevant as a success factor for large enterprises and most relevant to HEI (36 % compared to almost 60 % of respondents fully agreed.

The survey further contained three questions focusing on the assumption that research consortia and participants that designed and implemented an exploitation strategy are more likely to succeed in market-orientated exploitation. Specifically, the questionnaire surveyed the importance of having a clear division of labour in the strategy, the ability to adjust the strategy based on the circumstances and the strategy being developed already in the early stages of the project. While the impression that including a clear division of labour in an exploitation strategy can be vital is fully shared by only 17 % of the respondents, 47 % fully agree to the importance to the strategies' flexibility as a success factor (43 % basically agreed). One third (plus another 43 % who basically agreed) of the respondents confirm the importance of a very early development of an exploitation strategy. The highest level of agreement can be observed in the group of large enterprises and among research organisations.

The face-to-face interviews produced evidence that a successful market-oriented exploitation heavily depends on the internal characteristics of the R&D project producing the outcome to be commercialised. The highest level of agreement can be observed in reference to the continuous exchange of information and knowledge between all project partners. More than half of the various project participants (57 %) fully agreed to the argument that this is actually safeguarding a successful market-oriented exploitation of research outcome, while an additional 36 % basically agreed. Another essential cornerstone is a comprehensive and clear consortium agreement on intellectual property rights: Again, 57 % of the responses were in full and 31 % in general agreement. Certain flexibility in the research and commercialisation stage was also attributed with a high relevance as positively affecting the success of market-oriented exploitation: 51 % of all respondents fully agreed to the respective statement bringing the total agreement up to 96 %.

The positive impact of early-on and continuous market awareness on the likelihood of successful market-orientated exploitation only slightly differs from aforementioned impact factors. However, the positive impact of the project coordinators' expertise on the one hand and the use of patents, trademarks, copyrights or design rights received a comparatively low level of agreement. 49 % of the respondents fully agreed to the assumption of a positive correlation of early-on market awareness and successful market-oriented exploitation of research outcome (39 % basically agreed). In contrast to that, only 37 % fully agreed to the project coordinators' competence as a key factor to successful commercial exploitation and approx. 20 % did not at all identify with the respective statement. The lowest level of agreement refers to a positive influence of intellectual property rights: 32 % fully agreed and more than a quarter basically disagreed with this statement.

Large enterprises seem to be especially sceptical about the positive influence of the project coordinators on the successful market-orientated exploitation. Since SMEs also show an above-average disagreement it seems that organisations that are stronger involved in the commercialisation process generally tend to agree less to the facilitating function of project coordinators.

In contrast, early-on and continuous market awareness is most relevant for large enterprises: 81 % of the respective respondents fully agreed to this particular statement, which is 32 percentage points above the average.

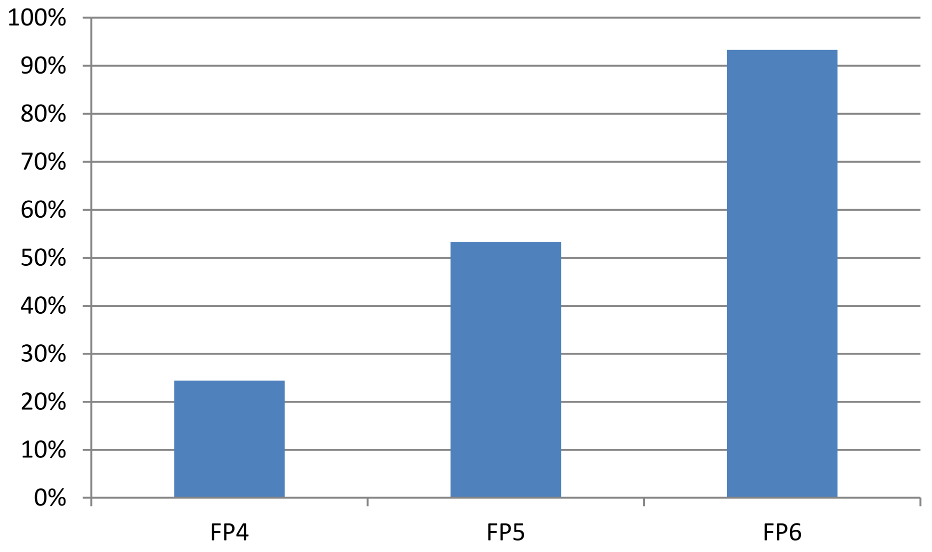
The following section focuses on the impact of external factors (i.e. external to the R&D project, its participants etc.) on the successful market-orientated exploitation of research outcome that were identified throughout the fieldwork: importance of follow-up funding and the current market. Two thirds of the participants fully agreed to a correlation between follow-up funding and successful market-oriented exploitation (another 31 % basically agreed) and only 5 % (basically) disagreed. In contrast, only 32% of all respondents consider the current market conditions as vital for market-oriented exploitation of research outcome, and almost one quarter did not see a direct correlation (at all).

Not very surprisingly, follow-up funding is most crucial to research organisations and the higher education institutions that in general are both (rather) non-commercial organisations with public funding as their main source for financial resources. 75 % of the research organisations fully agreed to the high relevance of follow-up funding for success in commercial exploitation and not a single research organisation disagreed with the statement. However, the level of agreement among companies is also around 50 %.

All in all, the majority of preliminary findings based on the fieldwork and presented in the two interim reports have been confirmed in their relevance for successful market-oriented exploitation. However, some were – if not rejected – rated much less important than expected.

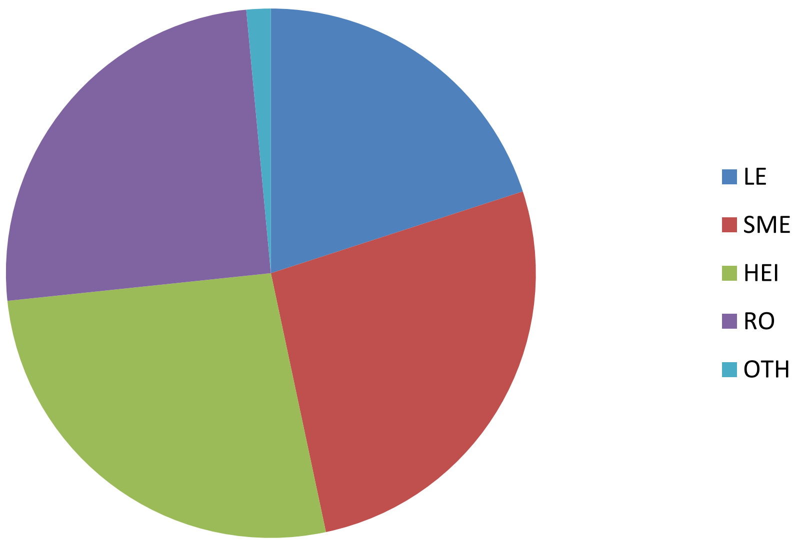
1.30.2. FIGURES

FP-PARTICIPATION OF RESPONDENTS



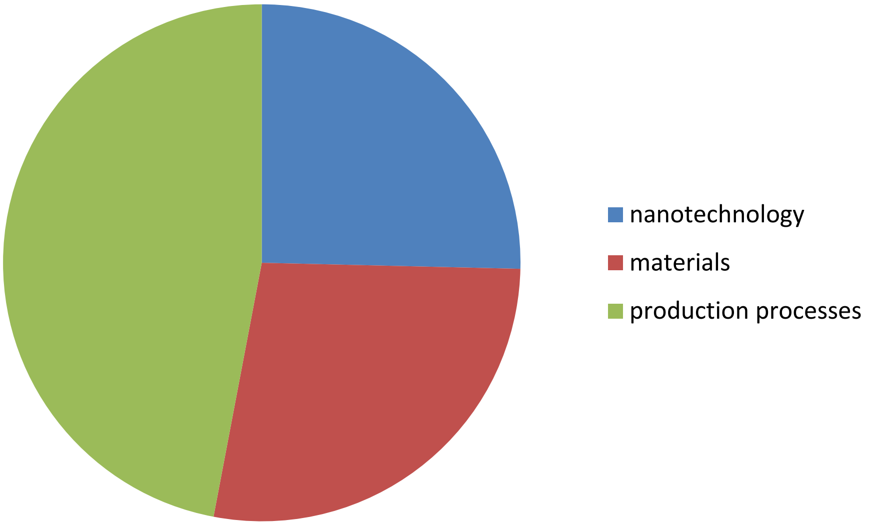
Source: Austrian Institute of SME Research 2012

ORGANISATION TYPE OF RESPONDENTS



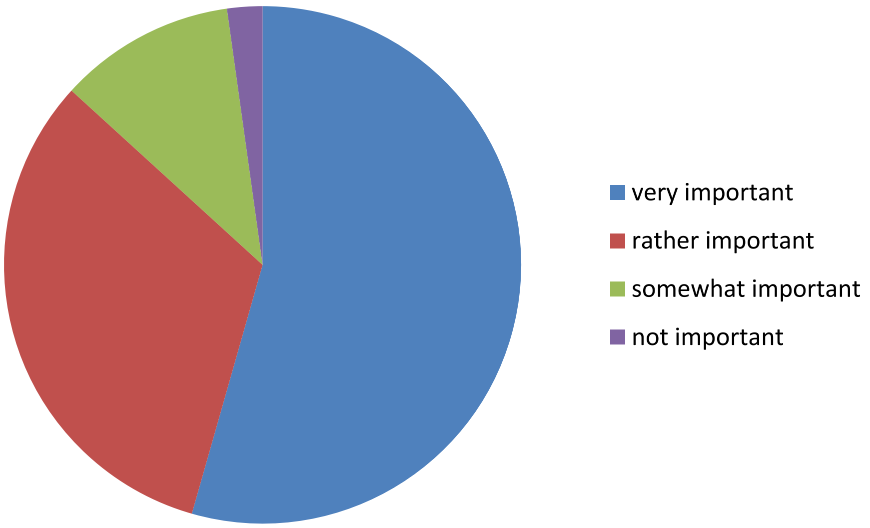
Source: Austrian Institute of SME Research 2012

NMP FOCUS OF RESPONDENTS



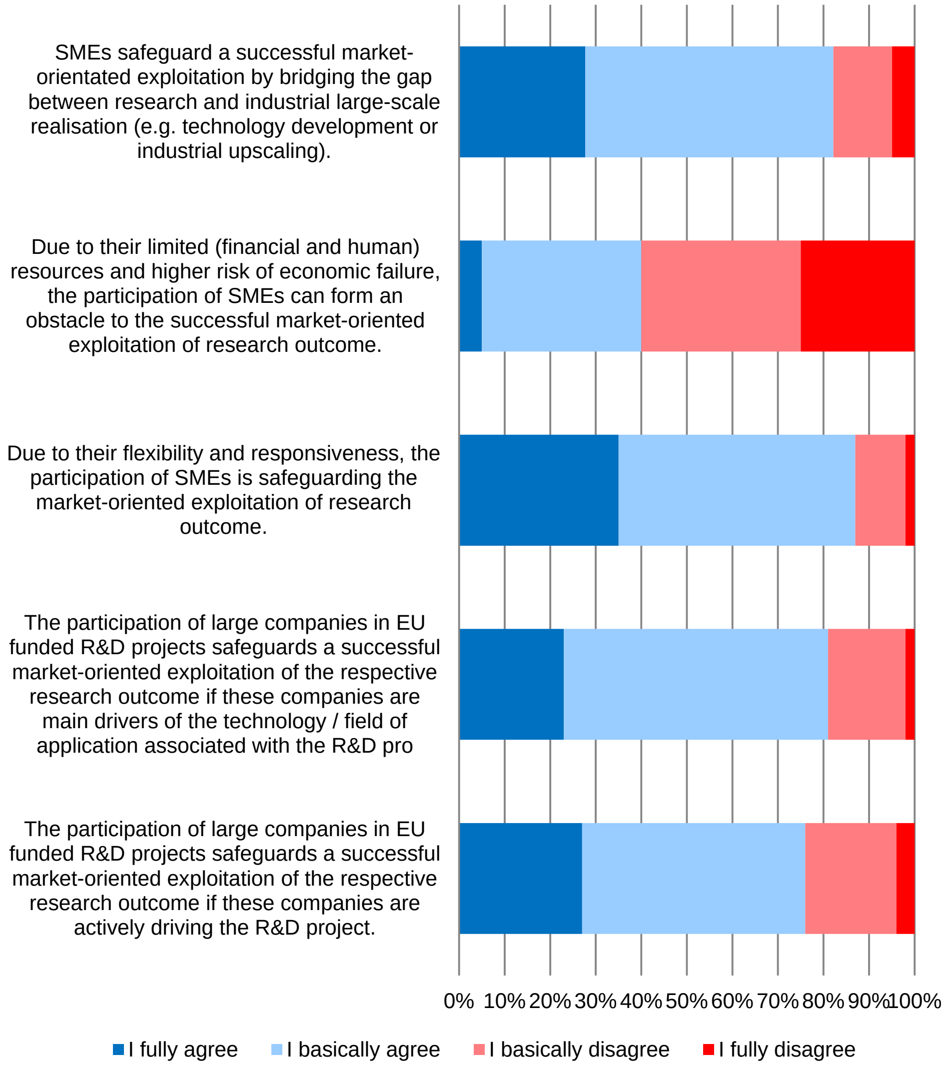
Source: Austrian Institute of SME Research 2012^

GENERAL RELEVANCE OF MARKET-ORIENTED EXPLOITATION OF R&D



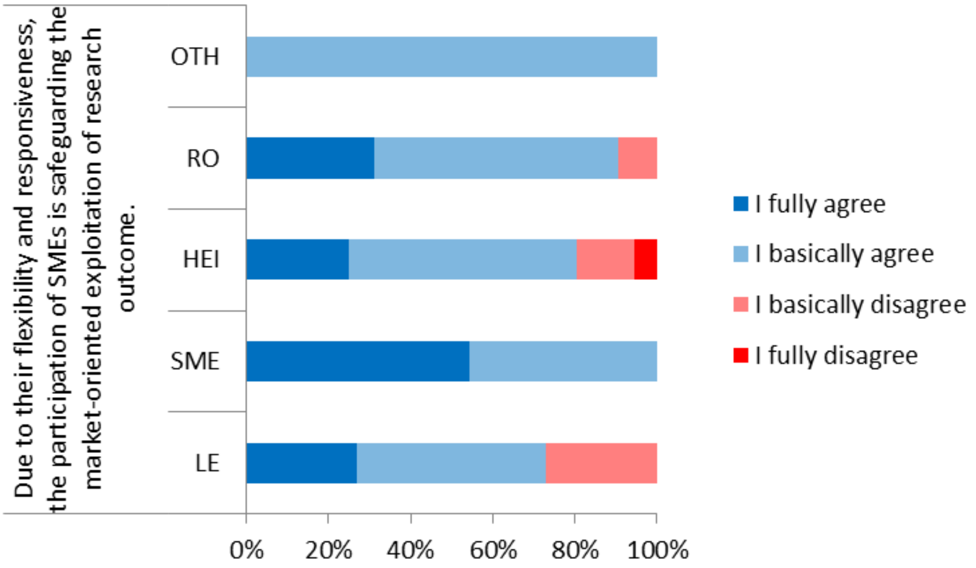
Source: Austrian Institute of SME Research 2012

COMPOSITION OF R&D CONSORTIUMS AS A SUCCESS FACTOR, I



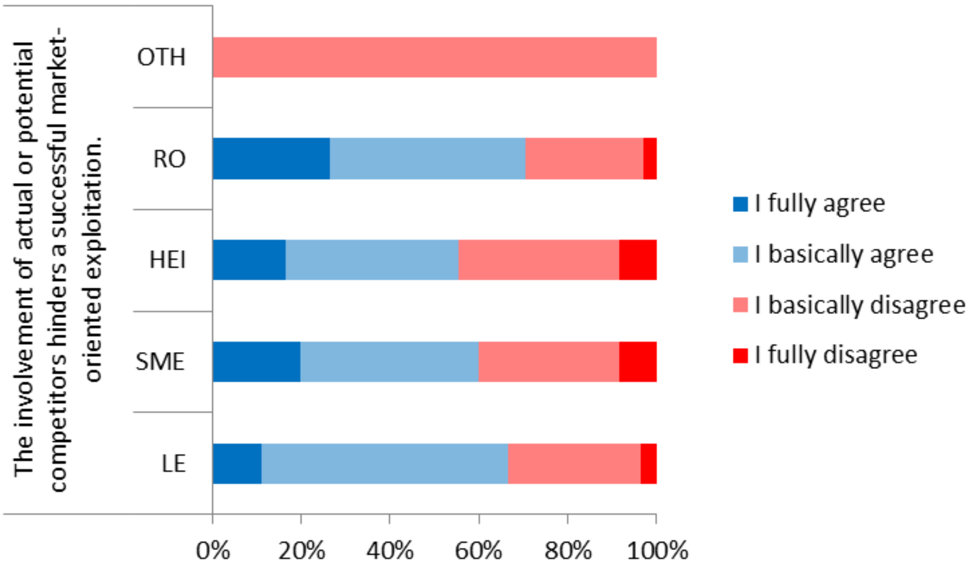
Source: Austrian Institute of SME Research 2012

INVOLVING SME AS A SUCCESS FACTOR FOR MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



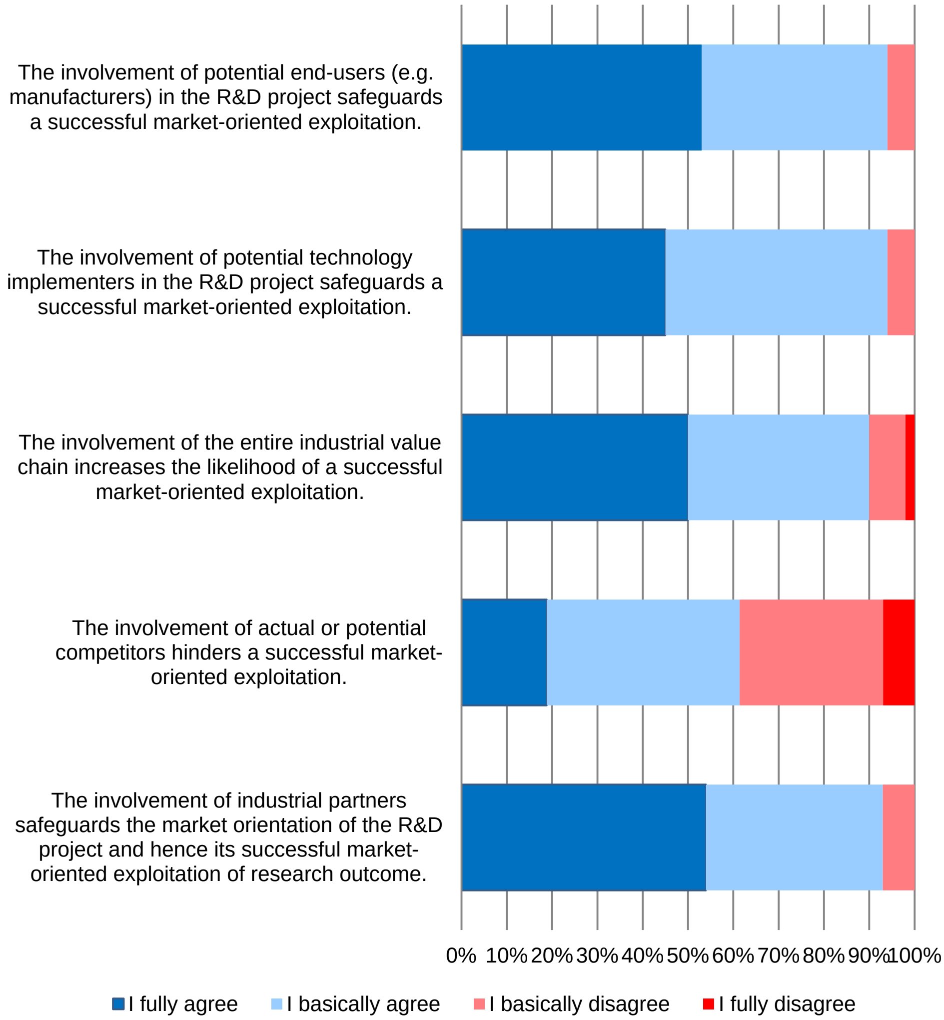
Source: Austrian Institute of SME Research 2012

COMPETITORS' INVOLVEMENT BEING A RISK TO SUCCESS IN MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



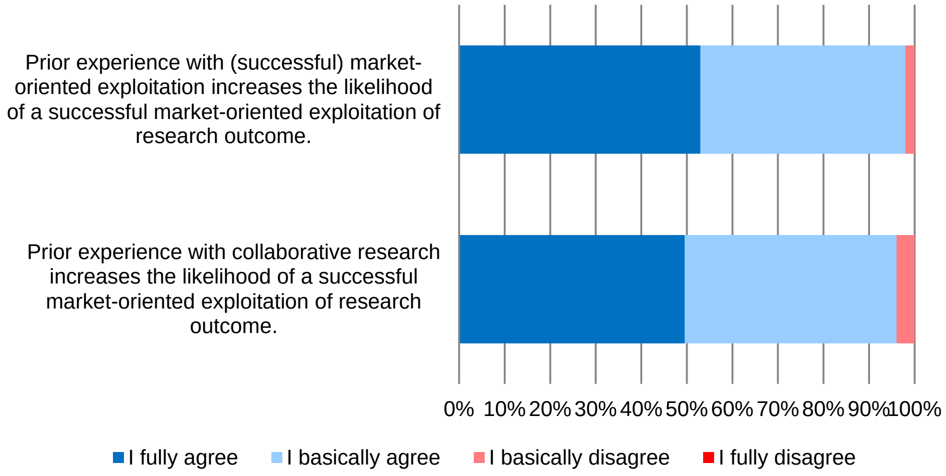
Source: Austrian Institute of SME Research 2012

COMPOSITION OF R&D CONSORTIUMS AS A SUCCESS FACTOR, II



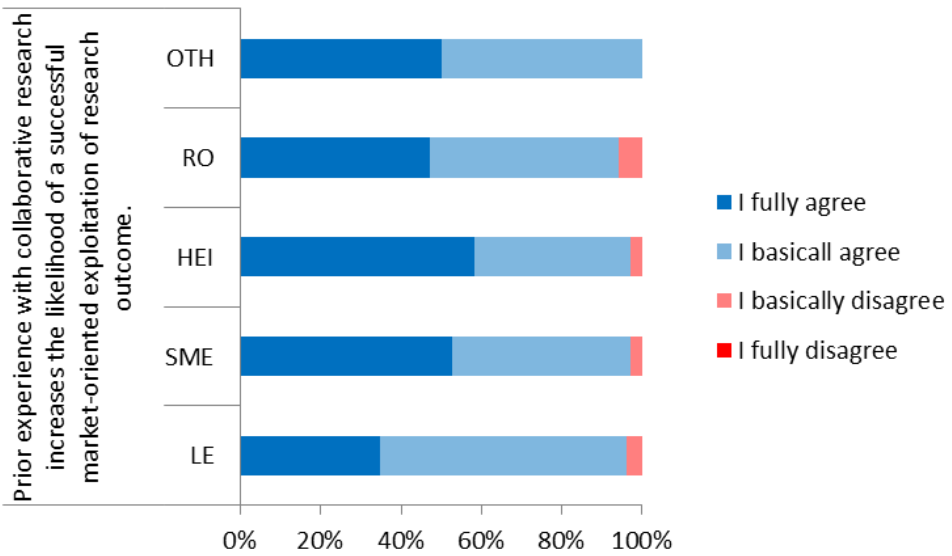
Source: Austrian Institute of SME Research 2012

PRIOR EXPERIENCE AS A SUCCESS FACTOR



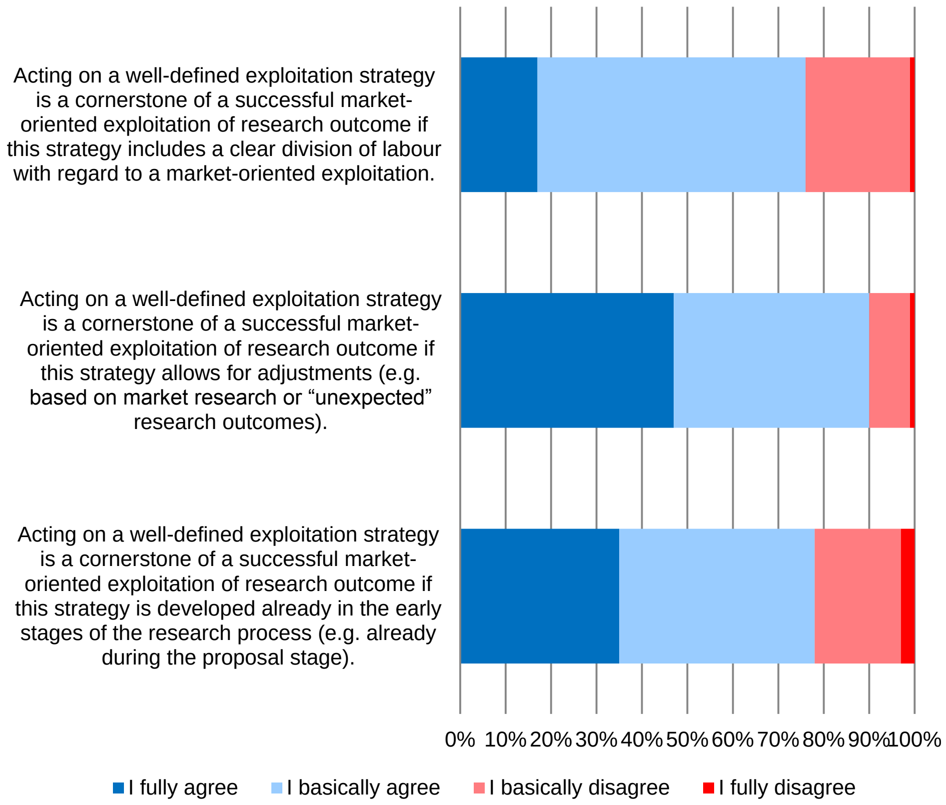
Source: Austrian Institute of SME Research 2012

PRIOR EXPERIENCE WITH COLLABORATIVE R&D INCREASING THE SUCCESS IN MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



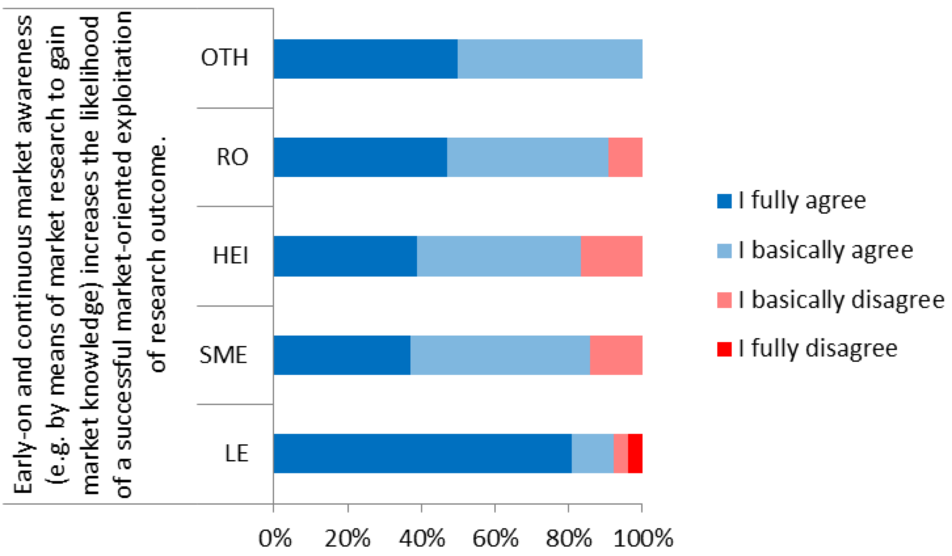
Source: Austrian Institute of SME Research 2012

EXPLOITATION STRATEGIES AS A SUCCESS FACTOR



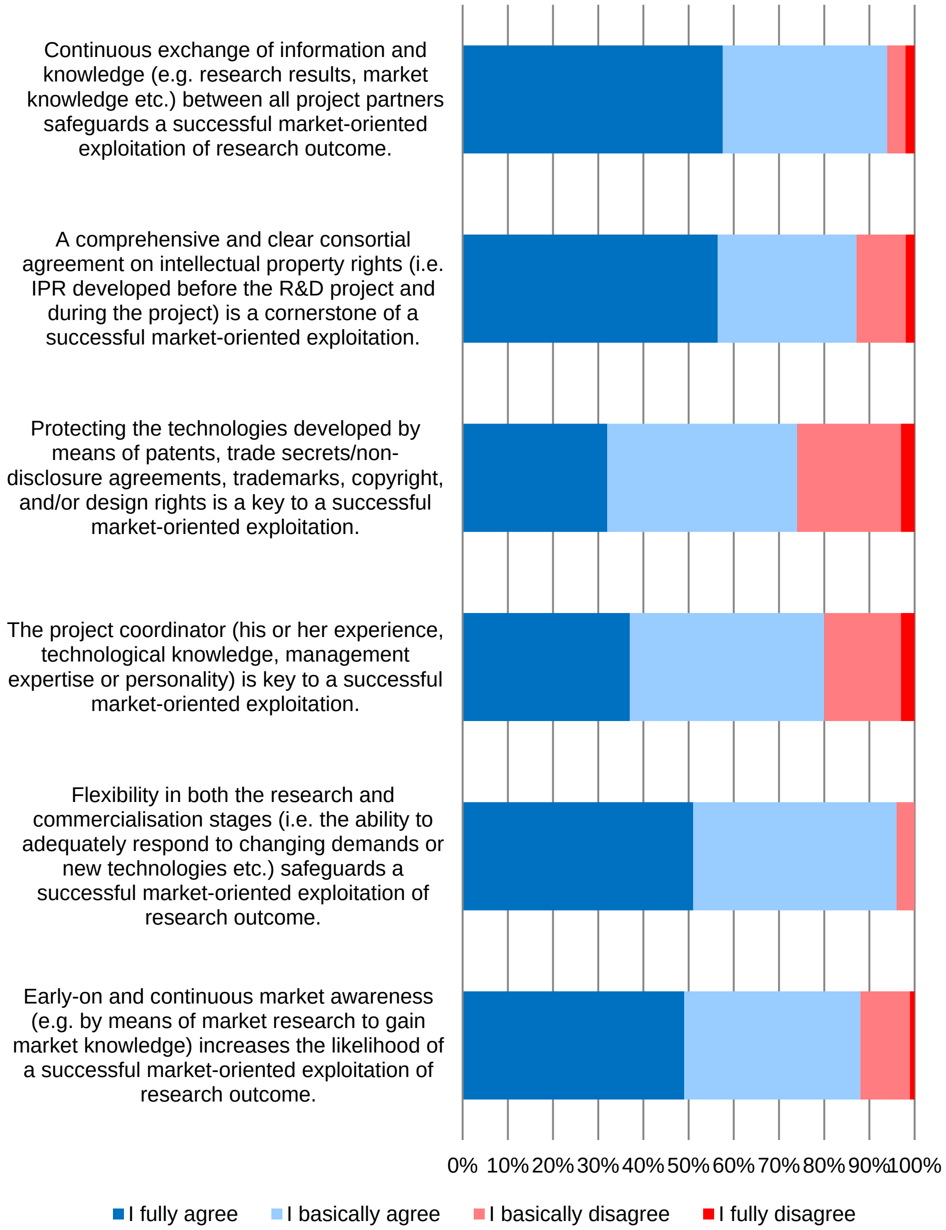
Source: Austrian Institute of SME Research 2012

EARLY-ON AND CONTINUOUS MARKET AWARENESS AS A SUCCESS FACTOR IN MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



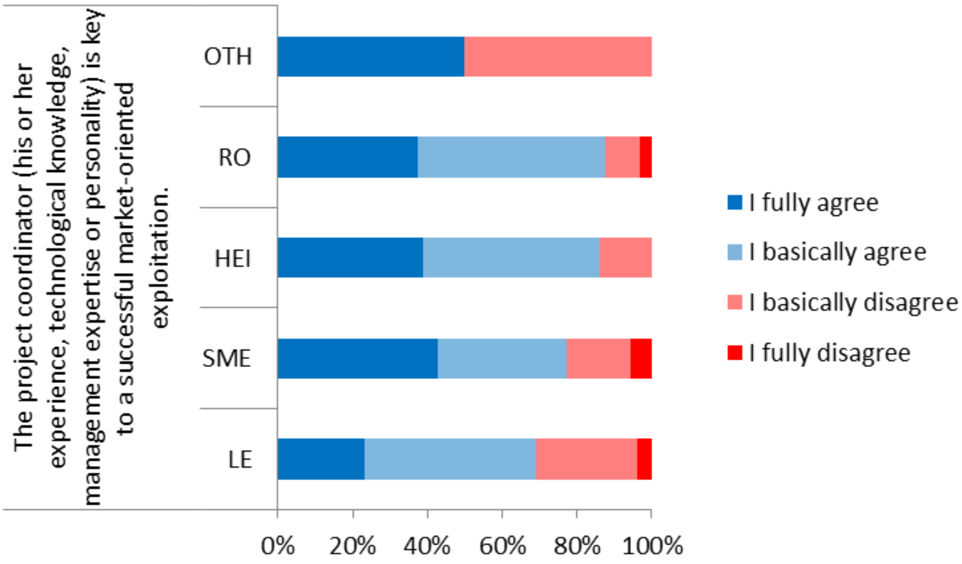
Source: Austrian Institute of SME Research 2012

BEHAVIOURAL ASPECTS AS SUCCESS FACTORS



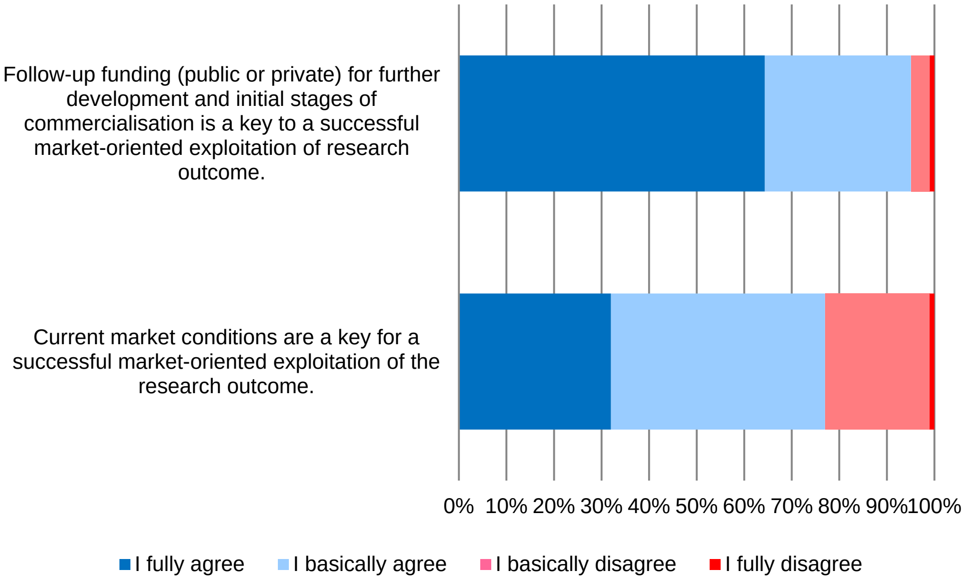
Source: Austrian Institute of SME Research 2012

PROJECTS COORDINATORS AND THEIR POSITIVE EFFECT ON SUCCESS IN MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



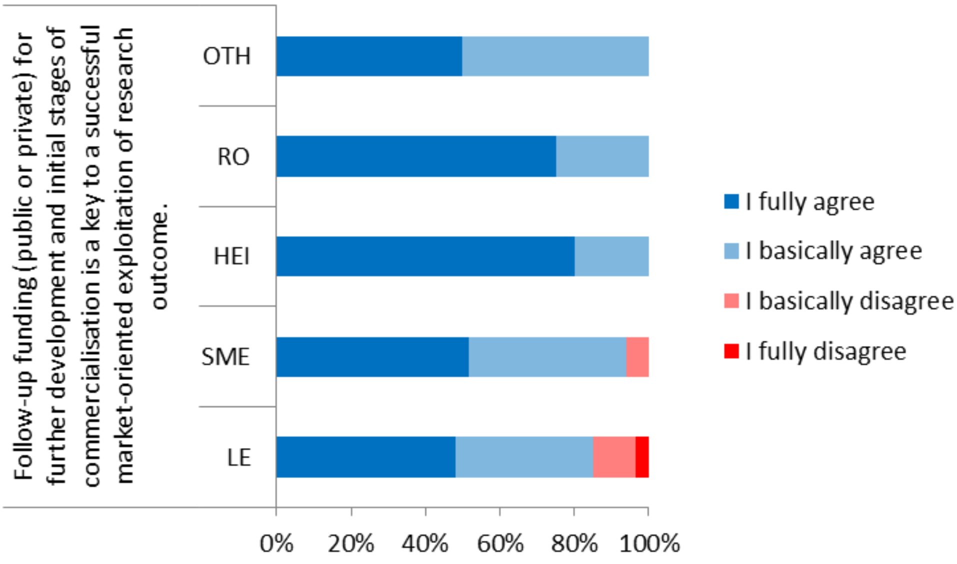
Source: Austrian Institute of SME Research 2012

FOLLOW-UP FUNDING AS A SUCCESS FACTOR



Source: Austrian Institute of SME Research 2012

FOLLOW-UP FUNDING AS A SUCCESS FACTOR IN MARKET-ORIENTED EXPLOITATION, AGREEMENT BY TYPE OF ORGANISATION



Source: Austrian Institute of SME Research 2012

1.30.3. QUESTIONNAIRE

#	question	scale
1	Please indicate your organisation (type):	Large enterprise (> 250 employees) Small or medium-sized enterprise (< 250 employees) Higher education institution (e.g. universities) Research organisation Other
2	Please indicate in which of the following European Framework Programmes you participated:	FP4 FP5 FP6
3	On which of the following NMP-areas do you usually focus your research activities?	Nanotechnology, -sciences Knowledge-based, multifunctional materials New production processes and devices
4	How important is market-orientation and market-oriented exploitation for your research activities in general?	very important rather important somewhat important not important
5	Prior experience with collaborative research increases the likelihood of a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
6	Prior experience with (successful) market-oriented exploitation increases the likelihood of a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
7	The involvement of industrial partners safeguards the market orientation of the R&D project and hence its successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
8	The involvement of actual or potential competitors hinders a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
9	The involvement of the entire industrial value chain increases the likelihood of a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
10	The involvement of potential technology implementers in the R&D project safeguards a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
11	The involvement of potential end-users (e.g. manufacturers) in the R&D project safeguards a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
12	The participation of large companies in EU funded R&D projects safeguards a successful market-oriented exploitation of the respective research outcome if these companies are actively driving the R&D project.	I fully agree I basically agree I basically disagree I fully disagree
13	The participation of large companies in EU funded R&D projects safeguards a successful market-oriented exploitation of the respective research outcome if these companies are main drivers of the technology / field of application associated with the R&D project.	I fully agree I basically agree I basically disagree I fully disagree

14	Due to their flexibility and responsiveness, the participation of SMEs is safeguarding the market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
15	Due to their limited (financial and human) resources and higher risk of economic failure, the participation of SMEs can form an obstacle to the successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
16	SMEs safeguard a successful market-orientated exploitation by bridging the gap between research and industrial large-scale realisation (e.g. technology development or industrial scaling-up).	I fully agree I basically agree I basically disagree I fully disagree
17	Early-on and continuous market awareness (e.g. by means of market research to gain market knowledge) increases the likelihood of a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
18	Flexibility in both the research and commercialisation stages (i.e. the ability to adequately respond to changing demands or new technologies etc.) safeguards a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
19	The project coordinator (his/her experience, technological knowledge, management expertise and personality) is key to a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
20	Acting on a well-defined exploitation strategy is a cornerstone of a successful market-oriented exploitation of research outcome if this strategy is developed already in the early stages of the research process (e.g. already during the proposal stage).	I fully agree I basically agree I basically disagree I fully disagree
21	Acting on a well-defined exploitation strategy is a cornerstone of a successful market-oriented exploitation of research outcome if this strategy allows for adjustments (e.g. based on market research or “unexpected” research outcomes).	I fully agree I basically agree I basically disagree I fully disagree
22	Acting on a well-defined exploitation strategy is a cornerstone of a successful market-oriented exploitation of research outcome if this strategy includes a clear division of labour with regard to a market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
23	Protecting the technologies developed by means of patents, trade secrets/non-disclosure agreements, trademarks, copyright, and/or design rights is a key to a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
24	A comprehensive and clear consortium agreement on intellectual property rights (i.e. IPR developed before the R&D project and during the project) is a cornerstone of a successful market-oriented exploitation.	I fully agree I basically agree I basically disagree I fully disagree
25	Continuous exchange of information and knowledge (e.g. research results, market knowledge etc.) between all project partners safeguards a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
26	Current market conditions are a key for a successful market-oriented exploitation of the research outcome.	I fully agree I basically agree I basically disagree I fully disagree
27	Follow-up funding (public or private) for further development and initial stages of commercialisation is a key to a successful market-oriented exploitation of research outcome.	I fully agree I basically agree I basically disagree I fully disagree
28	Are there any additional success or impact factors for a successful market-oriented exploitation of research outcome?	Open question

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European Commission

Innovation - How to convert research into commercial success story?

Part 1 : Analysis of EU-funded research projects in the field of industrial technologies

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The three publications «How to convert research into commercial success story?» aim to analyse how to successfully bridge the gap between research outputs and innovations' access to the market in the area of industrial and enabling technologies.

Three complementary approaches were followed:
This report retraces the pathways from research outcomes to commercialisation of EU-funded research projects in the field of industrial technologies.

The report «How to convert research into commercial success story? Analysis of innovation successes in the field of industrial technologies» describes commercial successes not necessarily funded by the European Union in the field of industrial technologies.

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