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Catapults contributing to Europe 2020

How to generate value by strategically engaging in EU activities

Muthu de Silva and Birgitte Andersen

The research into how Technology and Innovation Centres generate value by strategically engaging in EU activities has been an open innovation project by excellence.

The project was commissioned and funded by Innovate UK (*the new name for the Technology Strategy Board, the UK's innovation agency*) and undertaken by the Big Innovation Centre between January and December 2014.

The scope of the project was defined by Dr Sivasegaram Manimaaran and Dr Pilar Sepulveda. Appreciation goes to them and the rest of the Project Management Board for contextual discussions and valuable feedback. They are: Simon Edmonds, Mike Oldham, and Dan Hodges from Innovate UK; Paul John from the High Value Manufacturing Catapult; Prof. Jakob Edler from Manchester Institute of Innovation Research, University of Manchester; and Dr Puay Tang from Science and Technology Policy Research Unit (SPRU) at the University of Sussex.

Acknowledgement also should go to:

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- Secretary General Muriel Attané and Policy Officer Talita Soares of the European Association of Research and Technology Organisations (EARTO) for valuable insight
- Attendees of the Validation Event of the findings and for feedback and translation into the UK context held on 12 September 2014 at Europe House, Smith Square, Westminster, London. This includes representatives of 7 UK Catapult centres, The Department for Business Innovation and Skills, Innovate UK and Prof Terence Wilkins of the University of Leeds
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- Rapporteur of the Validation Event, Dr Ainurul Rosli, University of Wolverhampton
- Hub Director Helen Lawrence for effective operational support

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Launched in September 2011, the Big Innovation Centre is a hub of innovative companies and organisations, thought leaders and 'what works' open innovators. Together we enlarge our innovative capability, test and realize our commercial and public-purpose ideas in a non-competitive and neutral environment. We act as catalysts in co-shaping our innovation and business model strategies that are both practical and intellectually grounded. Our vision is to make the UK a Global Open Innovation and Investment Hub by 2025, and to build similar initiatives internationally. For further details, please visit www.biginnovationcentre.com

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Muthu de Silva and Birgitte Andersen

This report aims to understand how the UK Catapults can generate value by strategically engaging in EU activities, reviewing the practices and experiences of similar Technology and Innovation Centre initiatives in seven European countries.

Commissioned by

Innovate UK
Technology Strategy Board

Fast forward Europe 2020 ...

Exponential leaps in technology and innovation in areas such as – digital economy, satellite applications, low carbon, energy systems, precision medicine, cell therapy, high value manufacturing, and transport systems – have massively boosted sustainable growth and jobs, catalysed a greater social mobility, and revolutionised the quality of life for all groups within society and our cities. Despite the achievements of the UK Catapults, Technology and Innovation Centres do not rest on their laurels, but look to leap again into new waves of technology and innovation for the good of business, society and the future of Europe.

*This is the vision of the Big Innovation Centre for
what our Catapults could become by 2020*

Foreword



Catapult centres have been established in the UK to help bridge the gap between the ambitions of the UK's high growth businesses and the outputs of our world leading research base.

The centres are established in technology or market areas where there are large global opportunities; the UK has the industrial and academic capability to take advantage of the opportunity; and barriers to business growth can be addressed through support provided by Innovate UK and its partners in a timely manner with clear additionality.

Here, it is worth recognising that more than 95% of R&D is conducted outside the UK, and access to knowledge, markets, skills and partners is increasingly taking place on a global basis. And European programmes such as Horizon 2020 play a critical role in facilitating this global engagement.

Innovate UK is determined to help UK industry make the most of the opportunities presented by Horizon 2020. This is why we have brought in-house the National Contact Point experts, bid for, and am pleased to say, successfully won the opportunity to deliver the Enterprise Europe Network (EEN) in England, Northern Ireland and Wales, and established a permanent presence in Brussels.

This report makes clear the important role state funded technology and innovation centres in other European Member States, such as the Fraunhofer Institutes in Germany, TNO in the Netherlands and VTT in Finland, play in maximising the impact of these European programmes and in helping industry realise these benefits.

By seeking inspiration from others, as we did in establishing the Catapult centres in the first instance, we hope to inform and inspire the UK Catapult centres to engage actively with European programmes, and in doing so deliver on our shared ambition of delivering jobs and growth across the European Union.

A handwritten signature in grey ink, which appears to read 'S. Edmonds'.

Simon Edmonds
Director Catapult Programme
Innovate UK

Executive summary

State funded Technology and Innovation Centres play an important intermediary role in the European innovation landscape. They play an important role as open innovators in moving technologies and ideas from concept to commercialization within the innovation ecosystems where they operate. They enable companies to engage in R&D, technology and innovation activities that extend beyond their in-house knowledge, expertise and own resources. These Technology and Innovation Centres are generally established by national governments, including in several European Member States. They are established in areas that present large global market opportunities and where there is a national capability both in industry and academia that could enable a significant proportion of the value added activity to be captured, delivering jobs and growth to their national economies.

Technology and Innovation Centres, such as the recently established Catapult centres in the UK, are thus primed to operate in an environment increasingly characterised by global supply chains, with more open and collaborative models of innovation, with access to knowledge, markets, skills and partners increasingly taking place on a global basis.

The Europe 2020 strategy for growth and jobs, and the programmes through which this strategy is being implemented, such as Horizon 2020, provide an important route by which companies across the EU can not only access finance, but also build collaborations, networks and strengthen supply chains, which are vital to future growth.

In the past, such programmes have allowed European Technology and Innovation Centres to build on their core intermediary role to help industry develop practical solutions that can address societal challenges and market opportunities.

To understand the rationale for such engagement and how Catapults and other such organisations can position themselves to help realise the ambitions of the Europe 2020 strategy, the Big Innovation Centre conducted an evidence-based research project gathering intelligence (via online survey and interviews) from Directors and senior officials at 66 State funded Technology and Innovation Centres in seven European countries: German Fraunhofer Institutes; French Carnot centres; Organisations for Applied Scientific Research (TNOs) in the Netherlands; Finland's Technical Research Centre (VTT); Finland's Funding Agency for Technology and Innovation (SHOK-TEKES) centres; Denmark's Authorised Technological Service Institutes (GTS); Norway's Foundation for Scientific and Industrial Research (SINTEF), and Spain's Tecnalia.

This report aims to understand and demonstrate why and how Technology and Innovation Centres generate value by strategically engaging in European Union initiatives, by presenting examples and reviewing the (best) practices in seven European countries. An aim is in particular to understand how the

UK Catapults can best contribute to, and benefit from, delivering the Europe 2020 strategy.

KEY FINDINGS

WHY Catapults should engage in EU programmes and projects?

Benefits:

Benefits achieved through engaging in EU programmes relate to accessing new knowledge and capability, building strategic networks, new opportunities for market growth, alongside access to funding and infrastructure. Thus, EU funding creates long-term benefits beyond specific project outcomes.

EU programmes also provide unique and complementary benefits when compared to national and industry funding. EU programmes and associated projects are generally larger, require a wider breadth of expertise and can now, under Horizon 2020 in particular, support a wider range of Technology Readiness Levels (TRLs) spanning concept to market.

ENABLERS: Five factors which will govern successful EU engagement by individual Catapults:

1. Strategic alignment: The strategy for EU engagement must align with the vision, strategic direction and expertise of the Catapult, such that the EU projects complement national priorities and associated activities.
2. Strong consortium: The consortium must be strong with all partners able to contribute and provide complimentary expertise to the core objectives of the projects.
3. Ability to influence: The Catapults should seek to leverage strong links to industry, associated insights and expertise to identify requirements and inform EU policies and priorities.
4. Support services and access to funds: Sufficient support locally or collectively must be in place to catalyse Catapult's EU engagement; e.g. an understanding of calls and procedures.
5. Policy alignment: The degree to which stable and proactive government actions at the national level align with the EU strategies.

*Dr Muthu de Silva
Leader: Entrepreneurial CoCreation.
Big Innovation Centre*

*Professor Birgitte Andersen
CEO and CoCreator
Big Innovation Centre*

Table of Contents

Executive summary.....	6
EU OPPORTUNITIES: Setting the scene.....	9
1.1. Introduction and report aims	9
1.2. Catapults in the era of openness	11
1.3. Europe 2020: The opportunity for Technology and Innovation Centres to contribute	12
1.4. Our approach	14
WHY: Benefits Technology and Innovation Centres gain through EU engagement.....	18
2.1. EU funding enables Technology and Innovation Centres to engage in unique research, innovation and technology activities.....	18
2.2. EU funding creates benefits beyond project specific outcomes.....	23
HOW: Factors which lead to successful EU engagement by the Technology and Innovation Centres.....	30
3.1. Factor one: Strategic alignment.....	30
3.2. Factor two: Strength of consortium.....	34
3.3. Factor three: Ability to influence	39
3.4. Factor four: Support services and access to funds	44
3.5. Factor five: Stable and proactive government actions	49
Appendix 1: Indicators used as evidence base captured via online survey and interviews	51
Appendix 2: Regression Analysis	58
Contact details	59

EU OPPORTUNITIES: Setting the scene

1.1. Introduction and report aims

Catapult centres were established in the UK by the Technology Strategy Board (now known as Innovate UK), following an announcement by Prime Minister, David Cameron in 2010. The decision to do so was informed by the Hauser Review¹ of Technology and Innovation Centres. The centres play an important role as ecosystem players by providing business, universities and other organisations with access to the best technical expertise, infrastructure, skills and equipment in order to act as open innovators in moving technologies and ideas from concept to commercialization within the innovation ecosystems. This enables companies to engage in R&D, technology and innovation activities that extend beyond their in-house knowledge, expertise and own resources.

Seven Catapults were established in the years following the initial investment worth over £200m and since then, additional funding has been found to both scale up the activities at some of the seven centres and enable a further two to also be established.

BOX 1: UK Catapult Centres

- High Value Manufacturing (HVM) Catapult
- Cell Therapy Catapult
- Satellite Applications Catapult
- Offshore Renewable Energy Catapult
- Digital Catapult
- Future Cities Catapult
- Transport Systems Catapult
- Energy Systems Catapult
- Precision Medicine Catapult

Together with private investment and competitive R&D funding, the combined commitment to the Catapult centres over their first five years, will be nearly £1.5 billion. As with their European counterparts, the UK centres have been established to support the growth of national businesses in areas where there are large global markets and there is a critical mass of capability to capture a significant proportion of the global value chain (see BOX 2).

Given the nature of the markets in which the Catapults are active, it is worth reflecting on the fact that most R&D and innovation is conducted outside of the UK and many market leaders are global firms. Therefore, Catapult centres need to operate in foreign markets in order to tap into this wider pool of international resource.

¹ The Current and Future Role of Technology and Innovation Centres in the UK. A Report by Dr. Hermann Hauser For Lord Mandelson, Secretary of State Department for Business Innovation & Skills. (March 2010)

BOX 2: Criteria for establishing a Catapult centre:

- Predicted global markets are worth billions of pounds
- The UK has a world-leading research capability
- The UK business base demonstrates the necessary absorptive capacity to exploit the technology developed
- The UK can attract and anchor the knowledge intensive activities of global mobile companies
- The Catapults deliver national strategies

*Technology and innovation centres. Closing the gap between concept and commercialisation.
Technology Strategy Board, Strategy and implementation plan, May 2011.*

This naturally means Catapult centres are ‘born global’ and need to engage in international activities, not least to widen the pool of knowledge, build new markets and networks, develop relationships with potential customers and help UK companies internationalise.

This report aims to demonstrate why and how Technology and Innovation Centres such as the Catapult centres generate value by strategically engaging in European initiatives, by reviewing the (best) practices across seven European countries. An aim is in particular to understand how Technology and innovation Centres, such as the UK Catapults, can best contribute to, and benefit from, delivering the Europe 2020 strategy.

To do so, we have investigated what benefits Technology and Innovation Centres generate from EU activities when compared with purely national initiatives. We then studied how Technology and Innovation Centres gain these additional benefits, including the strategies they adopt to identify priorities, partners and allocate internal resource. Finally we investigated the barriers faced by Technology and Innovation Centres when engaging in EU activities and the approaches they took to overcome these.

As Catapult centres are relatively new entities, understanding how similar European Technology and Innovation Centres contribute to achieving EU objectives while also delivering to their national agenda can help both inform their approach and maximise their impact.

“Much of the inspiration behind what we’re doing has come from looking at this internationally, at international best practice and how best UK can compete....”

*Rt Hon Dr Vince Cable MP,
Secretary of State for Business, Innovation and Skills (October 2012, IET)*

1.2. Catapults in the era of openness

Catapult centres are positioned centre stage in the UK's innovation ecosystem. A key element of this positioning is their ability to understand the ecosystem contributions, needs, situations, and cultures of different actors, mainly businesses and universities but also other organisations, and in doing so address a combination of market and system failures that will otherwise stifle innovation. A recent review of the Catapult network by Hermann Hauser² highlighted the contributions they have already begun to make through their unique role in the UK's innovation system.

BOX 3: What Technology and Innovation Centres in Europe do as open innovators

The international evidence is unambiguous. Despite their differences, a survey of 30 Technology and Innovation Centres across seven European countries shows that they all play an important role as open innovators in moving technologies and ideas from concept to commercialisation within the innovation ecosystems where they operate. Success is delivered in a number of different ways, including:

- As an anchor and catalyst into markets, innovative sectors, universities & Public Research Organisations (PROs), finance and capital structures.
- Continuously contributing to and delivering national innovation and research strategies for growth and, for the most part, being involved in their design and development.
- Reducing the risk associated with innovation by helping firms extend their capabilities and resources in a variety of ways. For example, they act as hubs for SMEs to go beyond their capacity and provide consulting, training, testing and certification, or market research services.
- Enable knowledge, resources, IP and skills to flow between businesses and the wider innovation ecosystem.
- Engaging with higher education institutions, training PhD students and informing the development of skills at all levels.

Andersen and Le Blanc, E. (2013): Catapult to success: Be ambitious, bold and enterprising. Big Innovation Centre report. Commissioned by the TSB, ESRC, and IET.

While the business models of Technology and Innovation Centres across Europe vary, they generally undertake activities that span the development of in-house knowledge and capability to the commercialisation of new technologies and processes by business. They do so by integrating three modes of funding – public allocated; public competitive; and the rest should be obtained privately via the market. This provides funding to develop in-house competence and capability, work in partnership with others, and catalyse markets,

² Review of the Catapult network - Recommendations on the future shape, scope and ambition of the programme

technologies and sectors.

EU funding count for about 15 % of total funding to Technology and Innovation Centres on average³ although it varies *hugely* across organisations. The dynamic benefits span beyond the individual projects, as we will see in Section 2.

1.3. Europe 2020: The opportunity for Technology and Innovation Centres to contribute

Building on the strategies for Europe 2020, the European strategy for growth and jobs, and its flagship initiatives including the Innovation Union and Digital Agenda for Europe, the European Commission's Horizon 2020 programme offers Catapults and other Technology and Innovation Centres an important platform through which they can engage in international collaborations that can support innovation in the public and private sectors, to improve the quality of life and build economic competitiveness in Europe.

The Horizon 2020 programme complements national efforts to support research and innovation with a view to:

- Strengthening the EU's position in science
- Strengthening industrial leadership in innovation including through major investments in key technologies, and
- Addressing major societal challenges such as climate change, sustainable transport and mobility, ensuring food safety and security, and an ageing population.

Furthermore, by complementing funding by individual Member States it seeks to enhance efforts and allow for a smarter use of resources.

To deliver on the strategic objectives of the Horizon 2020 programme, businesses, universities, public research organisations, financial institutions, citizens, and governments – need to be more open, more networked, more collaborative, and more absorptive of external ideas. This is both a challenge and an opportunity for Technology and Innovation Centres.

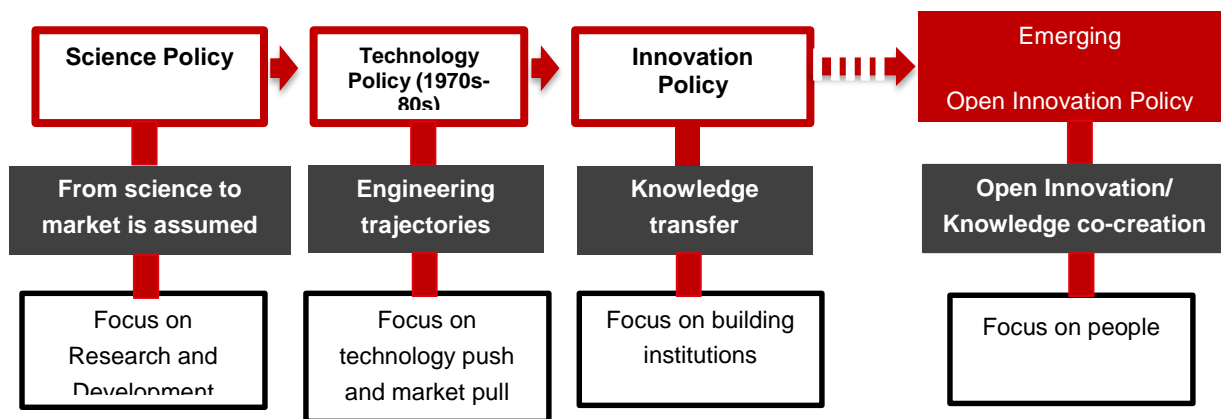
The collective co-creation approach is more than simply sharing risk and reward; it encapsulates the integration of the entire innovation ecosystem, and is about co-innovating new markets and more effective business models, integrating supply chains which would not exist otherwise⁴.

³ See Andersen and Le Blanc, E. (2013): Catapult to success: Be ambitious, bold and enterprising. Big Innovation Centre. Commissioned by the TSB, ESRC, and IET

⁴ This ecosystem version of the open innovation concept is hence broader than that coined by Henry Chesbrough who arguing that firms can and should use external ideas as well as internal ideas – and internal and external paths to market – to advance their technology. See Boosting Open Innovation

How organisations – or people within them to be precise – absorb each other’s ideas, needs and propositions and then shape actions is key to the co-creation process. It is evident that this has engendered a paradigm shift in policy from innovation institutions to innovation as a process (see Figure 1.1), and that a key role for Technology and Innovation Centres is to build the absorptive capacity from concept to market to deliver an effective role as an intermediary in such an environment.

Figure 1.1: Paradigm shifts in science, technology and innovation policy



- Government policy has evolved from the linear model of science policy in the 1950s–60s (i.e. a research-driven approach), which primarily focused on supporting the basic research base, to technology policy in the 1970s and 1980s with clear utilitarian – often engineering – perspectives (i.e. technology push and market pull approaches). More recently, innovation policy in the 1990s–2000s incorporated a knowledge transfer mission through building institutions, e.g. technology transfer offices in universities and tighter intellectual property (IP) enforcement. A new open innovation ecosystem landscape has now emerged, with a major focus on people within the organisations co-creating solutions to their own as well as socio-economic challenges within an open innovation infrastructure
- Even though the major focus and activities in each historical epoch of science, technology and innovation policy were different in each era, it should be noted that these are not contrasting shifts from one policy to another, but rather building upon the achievements of one to the other.
- Source: Andersen, B., De Silva, L. R., and Levy C. (2013): ‘Collaborate to innovate: How business can work with universities to generate knowledge and drive innovation’, Big Innovation Centre report. Commissioned by the UK Intellectual Property Office.

1.4. Our approach

We focused our attention on 122 state funded Technology and Innovation Centres across Europe, which exhibit similar characteristics to the UK's Catapult centres:

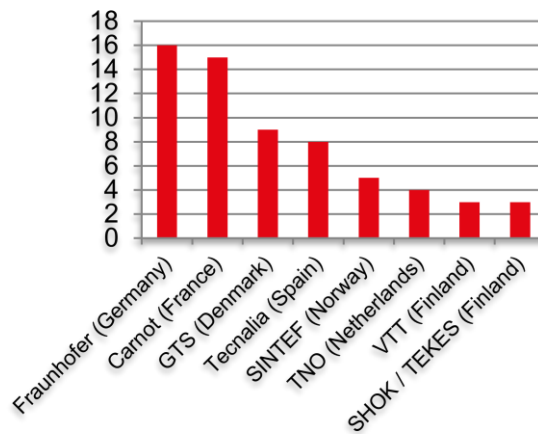
- German Fraunhofer Institutes (61 centres)
- French Carnot centres (34 centres)
- Organisations for Applied Scientific Research (TNOs) in the Netherlands (7 centres),
- Finland's Technical Research Centre (VTT) (1 centre)
- Finland's Funding Agency for Technology and Innovation (SHOK–TEKES) centres (6 centres)
- Denmark's Authorised Technological Service Institutes (GTS) (9 centres)
- Norway's Foundation for Scientific and Industrial Research (SINTEF) (1 centre), and
- Spain's Tecnalia (3 centres).

We conducted this research in several phases and also held a final validation event

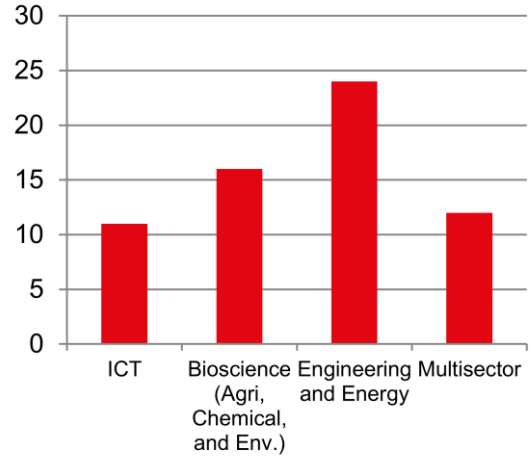
1. **An initial data gathering** - We carried out 12 in-depth interviews with Technology and Innovation Centres representing the 8 groups of institutes from 7 countries and one interview with European Association of Research and Technology Organisations (EARTO). Information gathered through these initial interviews were used to design subsequent data gathering phases.
2. **An online survey** – We then conducted an online survey, which was sent to a total of 157 representatives (i.e. Chief Executive Offices/ Directors) of the 122 Technology and Innovation Centres. The purpose of the online survey was to collect relevant quantitative data to investigate what benefits Technology and Innovation Centres generate through EU activities and what factors determine their ability to generate these benefits. We received 59 eligible responses (response rate – 40.1%). The respondent Technology and Innovation Centres were representative of the initiative, sector of operation, age and experience in EU activities (see Box 4). A majority of respondents were medium to large scale both in terms of number of employees and turnover, the distribution of which is similar to that of the sample of Technology and Innovation Centres (see Box 5).
3. **In-depth interviews** – A representative (in terms of initiative, sector of operation, number of employees, age and turnover) sample of 20 Technology and Innovation Centres of those who have responded to the online survey was selected for in-depth interviews. The main aim of in-depth interviews was to gather qualitative context specific data on what additional benefits Technology and Innovation Centres generate from EU activities when compared with industry and government funded projects and what are the enablers of the generation of benefits by Technology and Innovation Centres.

Box 4: Representativeness of responding Technology and Innovation Centres

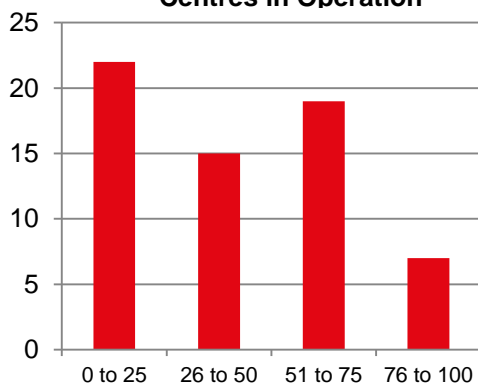
Technology & Innovation Centres



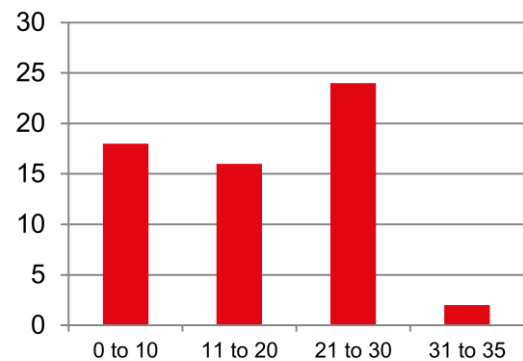
Technology & Innovation Centres by sector



Years Technology & Innovation Centres in Operation

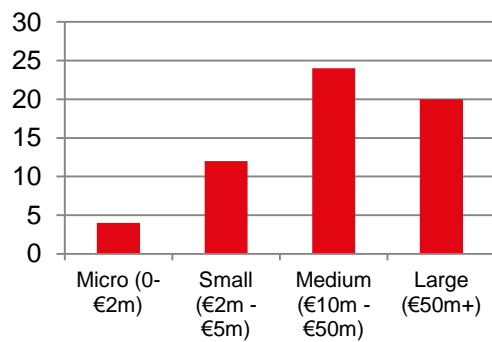


Years Technology & Innovation Centres engaged in EU Operations

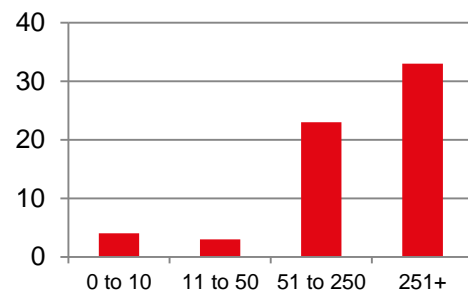


Box 5: The size of responding Technology and Innovation Centres

Annual Turnover



Number of employees



4. **Case studies** – Three detailed case studies were developed to provide further information on how Technology and Innovation Centres capitalise on their long-term networks of contacts, how Technology and Innovation Centres collaboratively work with multiple partners to inform EU policies and how Technology and Innovation Centres position EU projects within a portfolio of other activities carried out by them. The findings of these case studies are triangulated with the analysis of in-depth interviews and the online survey. We have integrated these into the discussions in section 3.2, 3.3 and 2.1 respectively.
5. **Evidence analysis and regression analysis** – Evidence collected through the 1, 2, 3 and 4 above approaches were analysed separately, and then, compared and contrasted to improve the validity.

The data gathered through the online survey was analysed using both descriptive and a regression analysis, the aim of which was to investigate what are the factors that govern Technology and Innovation Centres' ability to generate benefits from EU projects. Descriptive results are shown directly in the text. Regression analysis and results are presented in Appendix 2 and referred to in the text whenever appropriate.

6. **Validation event:** The analysis of the findings was presented for discussion and feedback and translation into the UK context (held on 12 September 2014 at Europe House⁵, Smith Square, Westminster, London).

Attendees:

Harald Egner	High Value Manufacturing Catapult
Caroline Twigg	Future Cities Catapult
Dr Nina Bauer	Cell Therapy Catapult
Dr Maurizio Pilu	Digital Catapult
Neil Ridley	Transport Systems Catapult
Prof Nick Veck	Satellite Applications Catapult
Dr Paul Ellsmore	Offshore Renewable Energy Catapult
Dr Lee Vousden	Department for Business Innovation and Skills
Prof Terence Wilkins	University of Leeds
Talita Soares	European Association of Research and Technology Organisation
Dr Pilar Sepulveda	Innovate UK
Mike Oldham	Innovate UK
Prof Birgitte Andersen	Big Innovation Centre
Dr Muthu de Silva	Big Innovation Centre

For more details on methodology, see Appendix 1.

⁵ Europe House is the UK base of both the European Parliament Information Office and European Commission Representation

EU Opportunities

EU projects boost Catapults' key role as open innovation anchor institutions in the innovation ecosystem

Be a catalyst when contributing to Europe 2020

- Europe faces critical economic and societal challenges that must be addressed to deliver growth and employment
- The EU Flagships approach is ambitious and bold in stimulating investment in people and open innovation processes to bring research, technology and innovations into the markets to solve the present economic and societal challenges.
- Businesses, universities, public research organisations, financial institutions, citizens, and governments need to be more open, more networked, more collaborative, and more absorptive of external ideas. This is a key challenge and opportunity for Technology and Innovation Centres.

WHY: Benefits Technology and Innovation Centres gain through EU engagement

Technology and Innovation Centres engage in EU projects to deliver benefits that cannot be realised through national (competitive) or industry funded contract research activities alone. There are however complementarities and having a balanced portfolio is essential for the Technology and Innovation Centres to generate benefits for their national economies and the EU.

The following sections of this chapter discuss these benefits in detail. As an introductory overview for the subsequent discussion, Figure 2.1 provides a summary of the benefits Technology and Innovation Centres generate through EU funded projects beyond the immediate financial inflow. These relate to the value created through access to networks, markets, knowledge and the skills base. The figure illustrates the extent to which they value the role of EU projects delivering these benefits.

2.1. EU funding enables Technology and Innovation Centres to engage in unique research, innovation and technology activities

Table 2.1 summarises the characteristics and benefits secured through engaging in three types of activity - EU, national (competitive) and industry funded projects, and forms the basis for the subsequent discussion in this section. Technology and Innovation Centres benefit from engaging in EU activities due to some key differences when compared to other funding (national and industry) in the following aspects: Networks, Scale of funding, Resource requirements to engage in projects, Project length, Topic areas, Commercial orientation, Knowledge exchange, Preparation and administration of projects, as well as Match-funding requirement.

2.1.1 Scale and ambition of projects

EU projects are generally larger in terms of the size of the network as well as the level of funding allocated. It enables participants to access expertise and achieve critical mass that is not always possible through contracts with individual firms or funding via Member States. Moreover, participants including Technology and Innovation Centres, benefit significantly through synergies between the partners of an EU consortia. These synergies arise due to complementarity between the expertise and resources of partners.

Figure 2.1: Benefits Technology and Innovation Centres generate through EU projects

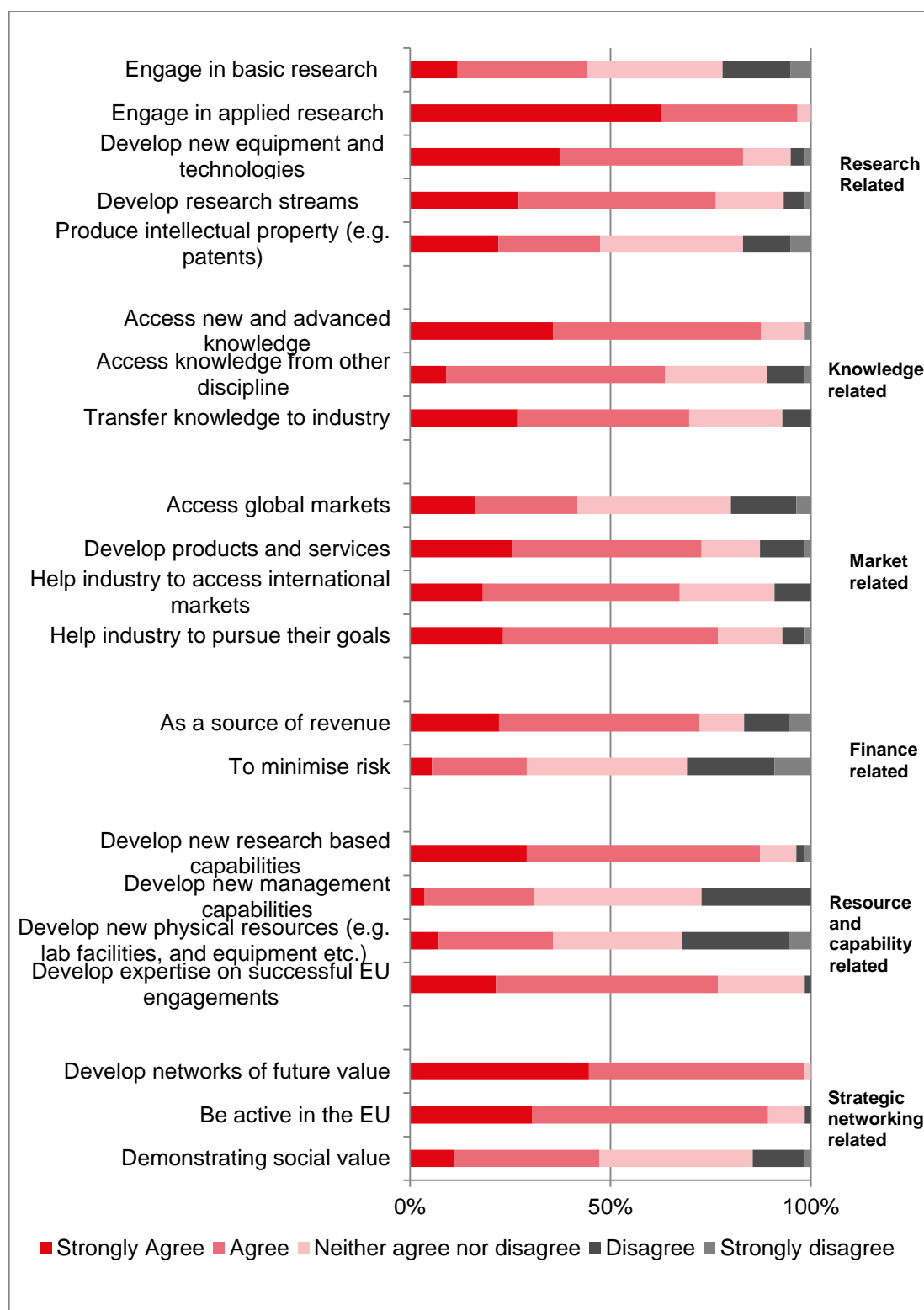


Table 2.1: Comparison between EU, National (competitive) and Industry funds

Aspect	EU funds	National funds (competitive)	Industry funds
1. Network	A larger number of international partners and bigger networks	Mostly comprises national partners and smaller networks	Mostly bilateral
2. Scale of funding	Mostly large-scale	Small- to medium-scale. Rarely large	Small to medium scale. Sometimes large
3. Non-financial capital the consortium require to engage in projects	For projects that require broader levels of expertise, critical mass of skills, technologies and infrastructure	For projects that do not generally have broad resource requirements as EU projects	For projects that do not generally have broad resource requirements as EU projects
4. Project length	Mostly mid- to long-term	Mostly short- to medium-term	Mostly short- to medium-term
5. Topic areas	Provides opportunities to engage in research in topics that complement national programmes.	Mainly in areas of national research priorities	Mainly in topics specific to companies
6. Commercial orientation	Now covers most TRL s	Ranges from low to high depending on the Member State	Closer to market. Higher TRL levels
7. Knowledge exchange	High with a strong focus on dissemination and/or commercialisation of results	High with a strong focus on dissemination and/or commercialisation of results. The extent of knowledge sharing depends on the size of consortia	Mostly knowledge transfer from Technology and Innovation Centres to the business. Often dissemination is not allowed
8. Preparation and administration	Complex and costly. More time consuming and resource intensive. Long lead time on funding decisions	Comparatively less complex and costly	Comparatively less complex and costly, funding is more readily available once approved
9. Match-funding requirement	Under Horizon 2020, low to mid TRLs can be funded at 100% of direct costs and high TRLs at 70%	National funding is subject to State Aid, but up to 100%	100% funding

It is worth noting that the survey showed well-established Technology and Innovation Centres (e.g. medium to large-scale Fraunhofer, VTT and Carnot institutes) deriving significant benefits from engagement in large scale projects. This was less pronounced in the case of the smaller, less established Technology and Innovation Centres and might reflect the availability of resources to engage in, and absorptive capacity to gain benefits from, large-scale projects.

However, accessing resources (e.g. technologies and physical capital) and expertise that are not available in-house were recognised as a benefit by a majority of Technology and Innovation Centres regardless of their geo-demographic characteristics.

Larger funding

"You can typically do larger things. For instance, I was coordinating a proposal where we were making a floating wind turbine, which cost 10 million Euros. This would be difficult to get within a national programme."

Arno van Wingerde, Business Leader- Research, Fraunhofer IWES

Larger funding and expertise

"Just to give you an example, we had a huge project with about 30 different partners where the aim was to produce a pharmaceutical protein and to bring it to clinical trials. This requires also a certain amount of money and expertise which – in many cases – you can't get from national funding. So with the amount of money you can get it is also somehow important to achieve goals which are far beyond a normal research project."

Prof. Stefan Schillberg, Head of Plant Biotechnology, Fraunhofer IME

Projects that need expertise, critical mass of skills, technologies and resources that are not available in-house

"....and in the same field there is a development you want, for example to develop bio-markers for animal health. Then you need to look at different diseases, look at different breeds, use different techniques and you know one country which is a specialist in that disease. So logically you need an EU project to really make progress because you need a critical mass of skills and resources that you don't have in-house, and you need to make a big technological step. There are no direct confidentiality issues in the first step because you are not going to go further than the pre-competitive phase but then you need a large EU project."

Marie-Helene Pinard-van der Laan, Researcher, ICSA Carnot Institute for Animal Health

2.1.2 Breadth of coverage

One of the unique characteristics of the Horizon 2020 is to cover a wide array of research and innovation ranging from concept to market involving a wider range of Technology Readiness Levels (TRLs) (see Box 6 for descriptions of TRLs) when compared to the previous Framework Programmes. There is scope now to support closer to market activities and integrate these with earlier stage research, which was not the case in the past.

Box 6: Technology Readiness Levels

TLR	Description
TRL 1	Basic principles observed
TRL 2	Technology concept formulated
TRL 3	Experimental proof of concept
TRL 4	Technology validated in lab
TRL 5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 7	System prototype demonstration in operational environment
TRL 8	System complete and qualified
TRL 9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Source: European Commission (2014) *Technology readiness levels (TRL), HORIZON 2020 – WORK PROGRAMME 2014-2015*

Use EU projects to engage in wider TRLs

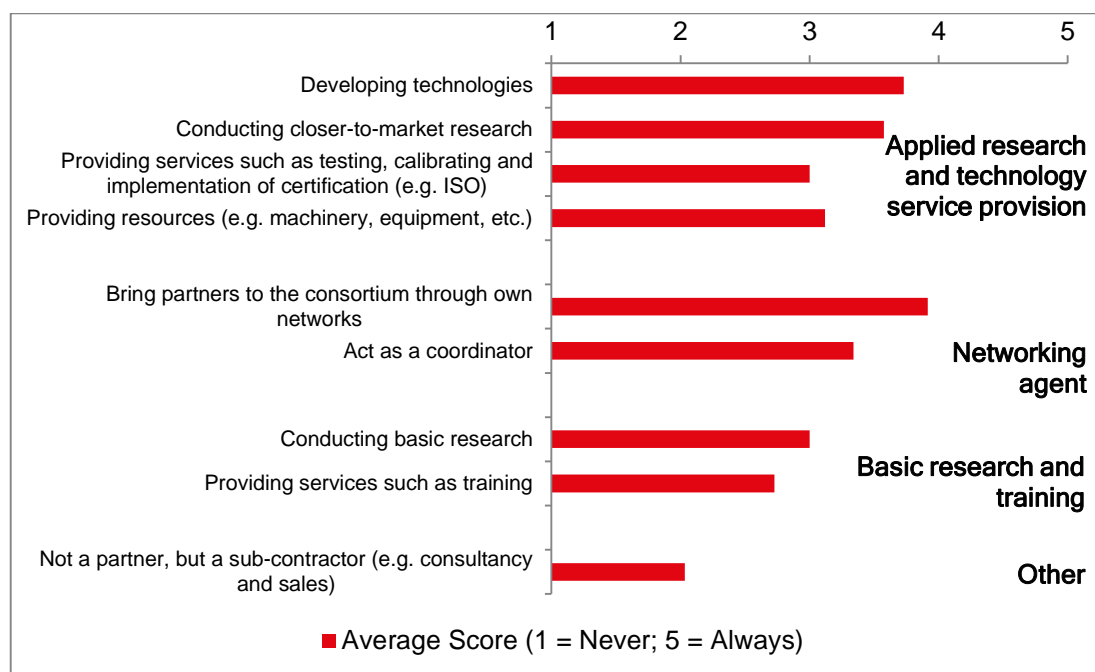
“We used EU funds mainly to engage in pre-competitive stage of research that is Technology Readiness Levels 4-6. Now with Horizon 2020 we hope to extend our engagement in higher TRLs as well.”

*Christian Boller, Director,
Fraunhofer Institut für
zerstörungsfreie Prüfverfahren
(IZFP)*

As illustrated in Figure 2.2 a majority of Technology and Innovation Centres frequently engage in wider TRLs covering different stages of development.

This breadth coverage, which now provides funding to support projects that also undertake activities such as prototyping and first replication in the market, such that their potential in real world environments can be better understood aligns well with the role and objectives of most Technology and Innovation Centres.

Figure 2.2: Nature of contribution by Technology and Innovation Centres to EU projects



2.2. EU funding creates benefits beyond project specific outcomes

2.2.1 Depth and breadth of access to knowledge, skills and networks

In addition to the direct benefits received through EU funding described in section 2.1 above, EU project experience also generates a myriad of long-term benefits to Technology and Innovation Centres and their academic and business partners. The international exposure through EU projects with multiple partners widens the networks of Technology and

Partners of future value

“For us as a Fraunhofer institute, EU projects provide opportunities to get in contact with industrial partners for future projects.”

Prof. Dieter Hofmann, Head of Strategy and Marketing Department, Fraunhofer Institute for Applied Polymer Research IAP

Innovation Centres and those of their partners (projects sometimes include up to 30–50 partner organisations), particularly with international businesses, universities and other Technology and Innovation Centres. Here, it is worth noting that Technology and Innovation Centres have in the past coordinated a significant proportion of projects and in doing so, develop consortia drawing in businesses from their own Member States.

This provides Technology and Innovation Centres and their partners with opportunities to engage in future collaborative work and access international markets. A majority of respondents, regardless of Technology and

Innovation Centre characteristics, highlighted the importance of the network building opportunities provided by EU projects. EU projects also provide opportunities for Technology and Innovation Centres to develop internal knowledge and skills as a result of openly innovating and exchanging knowledge with international players and experts. Working together with several partners from different countries is a pathway for Technology and Innovation Centres to enhance technical and market knowledge, and skills including co-creation skills.

Engage in topic areas beyond the scope of national programmes

"A more specific reason for being in EU Framework Programmes is that these contain specific topics in security, some of which we don't have in Denmark. We are an organization working in the area of safety and security. EU projects are very useful"

Carsten Damgaard, Danish Institute of Fire and Security Technology

Bring knowledge back to national economy

"Through that networking [we] get access to knowledge and exchange knowledge. Through such collaboration we can bring knowledge back to Denmark which will help us serve our role as a national GTS."

Jorn Rasmussen, Director R&D, DHI, GTS

Develop competencies, knowledge and skills

"Denmark is a small country; it's not possible that all our needs can be covered by national research programmes. There are areas where the competence level would be higher outside of Denmark than in Denmark so it's good for us to go into these EU programmes. We develop our competencies, knowledge and skills."

Moses Mengu, Director, International Centre, Danish Technological Institute (DTI), GTS

Excellent exchange of knowledge

"Some projects almost act as "conference projects" because they have about 50 partners, so every time there is a project meeting every partner sends at least one person, but typically 2 or 3, so there are 100–150 people not just presenting the work within the project but also presenting the results of various national projects. It is an incredibly worthwhile exchange of data. In terms of contacts and external significance, I think they are invaluable."

Arno van Wingerde, Business Leader – Research, Fraunhofer IWES

Effective and efficient knowledge sharing between a number of public and private partners across sectors accelerate the learning process and could also help Technology and Innovation Centres address complex challenges. Exploring new areas through

multidisciplinary projects also enables Technology and Innovation Centres to explore new opportunities to exploit their core technology/capabilities. Finally, EU projects also provide opportunities for Technology and Innovation Centres to benchmark and learn from one another.

2.2.2 Synergies between funding sources

EU funding enables Technology and Innovation Centres to generate unique benefits when compared to activity undertaken with national or industry funding. There are however interdependencies between these activities. There are funding, networking, competence and resource complementarities between EU, national and industry projects. National core funding is used by Technology and Innovation Centres to develop core competencies and capabilities in areas that fall within their remit that are too large or too risky for individual companies to tackle. Developing and demonstrating such competence at a national level

More time to strategically develop research

“If you have something in mind to do which is of interest to industry and which you must do in one or one and a half years you will not apply for European funding. You will ask directly from industry. Similar - it is useless to ask industry to take part in the project if it takes 3 or 4 years after the end of the project to get results.”

Dr Karl-Heinz Haas, Managing Director, Fraunhofer Nanotechnology Alliance, Fraunhofer ISC

underpins their ability to subsequently engage in, and derive benefit from EU projects. Furthermore, national core funding also allows Technology and Innovation Centres the opportunity to underwrite the costs associated with engaging in EU funded activities and derive the aforementioned benefits – EU funding will not cover the entire cost of a project for

Don't carry out EU projects only for funding, but aim to develop long term expertise

“We will never ever go for EU projects if we are not interested in the subject. We use EU funding to engage in large scale projects in the areas that we anyway want to develop. Not the other way around. You should not go to Europe only for funding. Do it in areas that you are active. The purpose is not to do EU programmes for the sake of it, but to use these to develop the expertise of our own people. TNOs are more like knowledge intensive organisations, which need to deliver expertise to our customers”

Prof. dr. ir. Egbert-Jan Sol, Director of Innovation – High-Tech Systems & Materials, TNO

a Technology and Innovation Centre. They must therefore be viewed as an investment in future capability and opportunities.

Networks and partnerships built at national level inform the strategic priorities of Technology and Innovation Centres and in turn shape partnerships for EU funding. In turn,

networks and competency built through EU projects cascade benefits into national projects.

Additional finances through EU projects

"In reality, there are no prioritizations between those domains [national and EU] and I must also say I don't see a choice between national and EU funding. They do not seem to be opposites in my understanding. On the contrary, national funding and EU funding go hand-in-hand if you're trying to build up a domain. Typically you do not have enough resource in a single project to build a core competence within an area, so you need that sort of symmetry between national and EU funding."

Asser Kalsboll, Business Development Manager, DELTA, GTS

Technology and Innovation Centres often initiate bilateral relationships with companies, with whom they successfully interact during the course of EU projects, to exploit the outputs of EU funded projects. The projects therefore provide a platform for Technology and Innovation Centres to conduct applied research that can subsequently be commercialised through industry funded contract research - thereby enabling publicly funded research to deliver impact. This synergy is crucial given the fact that industry funding is short-term and focuses mainly on closer to market projects.

Successfully securing and delivering EU projects also increases the reputational impact of Technology and Innovation Centres, which can in turn lead to further collaboration and opportunities in the future.

Industry projects are short term

"If industry give[s] you money, they want to have something in one or two years at the latest so they are a little bit impatient usually but if you can deal with these or similar topics in European-funded projects you get more time to look in more detail and we need this kind of research also."

*Dr Karl-Heinz Haas, Managing Director,
Fraunhofer Nanotechnology Alliance,
Fraunhofer ISC*

Strong ambition to expand networks and knowledge

"The GTS-institutes do not conduct EU projects only for money. They engage in these projects to develop strategic networks and expand their knowledge base. For instance, the collaboration with EU partners gives the opportunity to meet and work with new companies and academics. Collaboration that continue even after EU project lifetime"

*Ragnar Heldt Nielsen, Director, GTS –
Advanced Technology Group*

Technology and Innovation Centres form bilateral relationships with EU project partners after the project

“After the EU project we form bilateral relationships with industry partners with whom we had good relationships with to further develop outputs. Sometimes, it is not possible to reach the final stage of product development in a large consortium”

Jean Charles Guibert, Director of Technology Transfer, CEA, Director of MINATEC

Interestingly, our analysis revealed that partnerships with companies from the same Member State were more likely to lead to future activity. This highlights the value of EU projects in delivering value to the national economy. The analysis suggests that national partnerships are more trusted in providing advice and guidance on funding options and also help overcome natural uncertainties associated with collaborative work e.g. protection of intellectual property .

Leverage research funded by national projects

“One thing with the EU Programme is that it certainly gears up the research we are doing based on the national funding, so we can add much more knowledge to our knowledge base. I also regard it [EU funding] as an additional funding source to our national funding. It gives us extra knowledge and generally in most cases I would say it speeds up the process of particular research projects. Without the EU funding we would develop and grow in our research areas much more slowly than we are doing now.”

*Dr Jan Petersen, Team Leader, DFM,
Danish National Metrology Institute
GTS*

Multiplying national funding through EU projects

“If we do research on a specific project for, say, our government and we have comparable topics in the EU, then [...] we can engage in EU work and the results will also be beneficial for our government at that moment, so that’s what we call the multiplier effect. Also in the Framework 7 model you need your own institutional contribution, so we use contribution from our national government to match fund. This means you multiply your investment from several factors, so you get far better results from the programme.”

*Dr Albert van der Steen, EU/EDA
Manager, Defence, Safety and
Security, TNO*

A platform to develop long-term competency to engage in future industry projects

"We see the EU as a platform for producing knowledge and technology to engage in future industry projects. If you are looking for money we would go for industry. We see it [EU projects] as a strategic platform for building competence and technology platforms - both in a long-term perspective. [...] to be attractive to industry we have to build knowledge which they don't ask for today, but will need and ask for tomorrow. For example, we started building capacity on nanotechnology before industry was interested in nanotechnology."

Dr Unni Steinsmo, President and CEO, SINTEF Arctic Frontiers

WHY should Catapults engage in EU projects?

Benefits which can be achieved through EU funding are related to knowledge and capability, networks, market and financial value

EU funding enables Technology and Innovation Centres to engage in unique research, innovation and technology activities

- Suitable for projects that require more expertise, larger funding and physical infrastructure
- Suitable for medium to long-term research and innovation and in wider Technology Readiness Levels

EU funding creates benefits beyond project specific outcomes

- Increase depth and breadth of Technology and Innovation Centres' knowledge, skills and networks
- Generate synergies between EU, national and industry funding

HOW: Factors which lead to successful EU engagement by the Technology and Innovation Centres

Technology and Innovation Centres' ability to generate value from their involvement in EU activities appears to strongly depend on five key factors according to our research into the practices of 66 Technology and Innovation Centres:

- The extent to which the strategy for EU engagement aligns with the strategic direction and expertise of the Technology and Innovation Centre
- The likelihood of forming a strong consortium
- The ability to gain insights from, and shape the strategies of, EU objectives and policies
- The availability of sufficient internal resources for EU engagement
- Policy alignment – national and EU.

Having a clear organisational strategy for EU engagement

"The first advice I would give is that you should have an institutional or corporate strategyIt should be a planned effort to go in to these things as part of your livelihood. You cannot do it under pressure or as a casual activity. My second advice is that you should make some level of resources available, maybe as part of the strategy, to enter in to them."

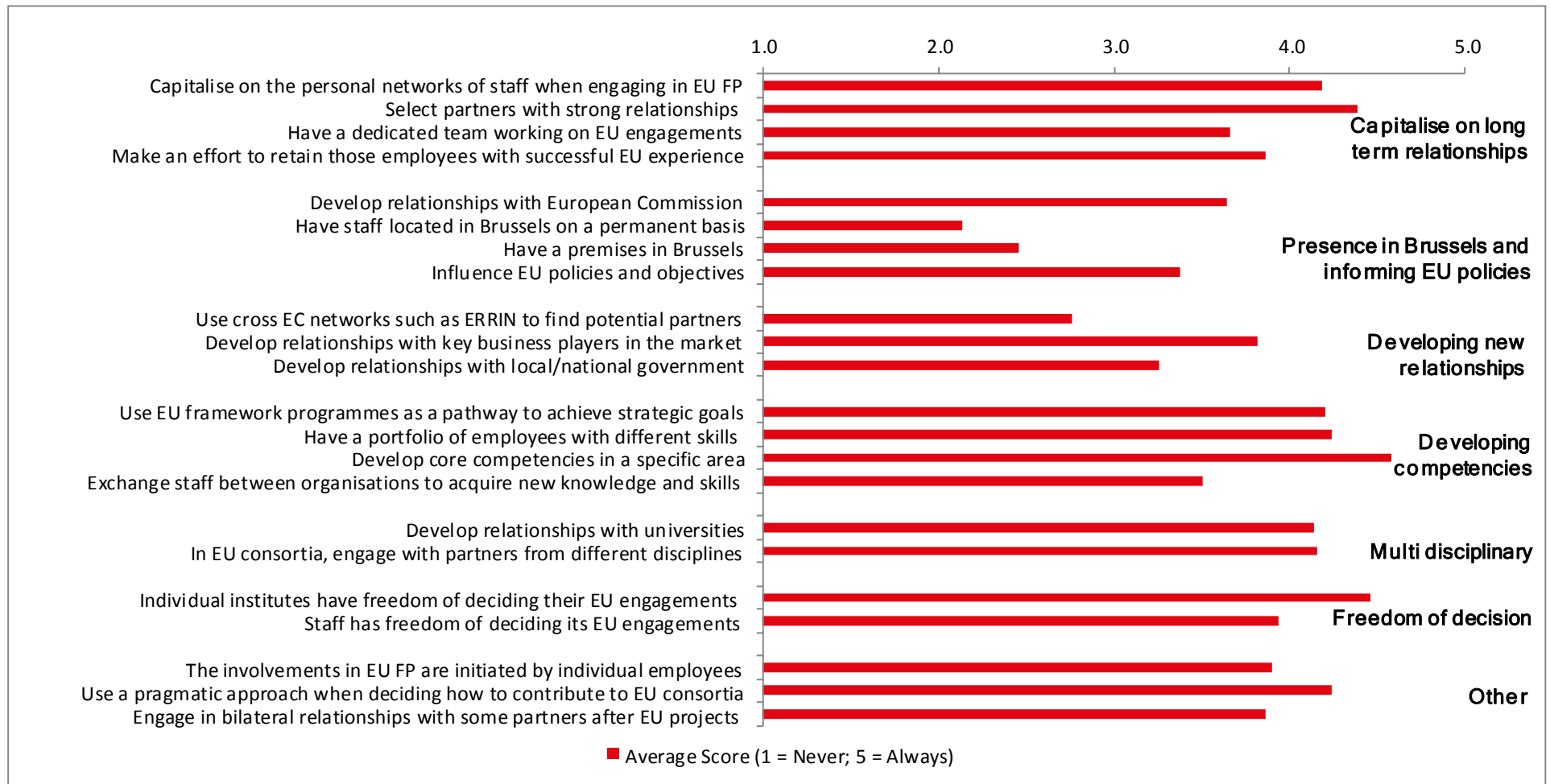
Moses Mengu, Director, International Centre, Danish Technological Institute (DTI), GTS

Figure 3.1 provides an overview of the practices adopted by Technology and Innovation Centres, in response to the original survey.

3.1. Factor one: Strategic alignment

A key for successful EU engagement is having a long-term strategy that aligns with the strategic direction and expertise of the Technology and Innovation Centre. However, newer, less established Technology and Innovation Centres may also have to adopt shorter term tactics to raise their visibility and credibility to overcome some unavoidable market entry barriers.

Figure 3.1: Practices adopted by Technology and Innovation Centres



3.1.1 Long-term view

The strategic priorities of a Technology and Innovation Centre are defined by taking into account national and EU policies and priorities, (national) industry needs and the areas of in-house expertise.

The survey results and subsequent discussions made it clear that having a long-term vision for EU engagement aligned with the Technology and Innovation Centre's strategic priorities are key to maximising the benefit derived from participating in EU programmes. This helps Technology and Innovation Centres leverage their existing expertise and to develop the know-how required for their organisation's future direction.

By way of example, the Netherlands Organisations for Applied Scientific Research's (TNOs) strategy and implementation road-map for each area they focus on are defined by taking into account internal expertise, and national, industrial, regional, EU and international strategies and priorities. Their subsequent engagement in EU programmes is then based on an evaluation of the specific programmes and calls against their national road map.

EU calls are thus evaluated by Technology and Innovation Centres on the basis of their potential return on investment, not only in monetary terms but on a broader basis that cover the tangible and intangible benefits identified in Chapter 2.

Organisational strategy - developed by considering national, industry and academic needs - shapes EU engagement

"A strategic plan of our organization is agreed with the ministries in charge of research and industry every four years. Research teams then fit their strategy in to this. A long process of consultation from both within and outside Inria is carried out when developing this strategic plan.

For instance, insights are taken from both industrial partners and other research organisations in France, including other areas such as medicine and biology. The strategy for EU engagement is shaped by this organisational strategy"

Stéphane Dalmas, Head of operations, Transfer & Innovation Department, Inria, Carnot

Interestingly, our survey further underlined the importance of having a clear organisational strategy for EU engagement – Technology and Innovation Centres derived less benefit in developing knowledge, capability and networks where engagement was based on the interest of an individual as opposed to the strategic objectives of the organisation (See Appendix 2 for results of the regression analysis).

The information flows are not however one way. While EU policies and objectives inform the priorities of individual Technology and Innovation Centres, as further discussed in section 3.3, Technology and Innovation Centres also use their own insights (primarily informed through their interactions at a national level) and strategies to inform EU policies and objectives.

3.1.2 Short-term tactics

As much as a long-term strategy for EU engagement is important, a lack of EU experience can also compromise the ability of less established Technology and Innovation Centres to engage in EU programmes. Our regression analysis (see Appendix 2) revealed that the greater the experience in EU projects, the higher the ability to engage in future EU activity. This points to some potential market entry barriers for young Technology and Innovation Centres.

Strategy for EU engagement is shaped by the Technology and Innovation Centre's expertise, industry needs and national objectives

"Institutes decide a strategy for EU engagement considering their research expertise, national objectives and market needs. Being an applied research organisation, we always look at industry needs...but the fulfilment of market needs always comes from excellence in science. We are the junction between excellence of science and industry needs, these are two key elements we take into account in the context of national objectives"

Dipl. Phys. Stephanie Jung, International Business Development, Strategy Development, Fraunhofer Gesellschaft

Young Technology and Innovation Centres should adopt short-term tactics

"If you haven't engaged in EU projects, you should adopt short-term tactics initially. First, for a couple of years you should somehow just get involved. It is better to start at least by engaging in one package.... Once you have the first project, which will be for three years, you know what you are good at, what could be done successfully"

Prof. dr. ir. Egbert-Jan Sol, Director of Innovation – High-Tech Systems & Materials, TNO

One strategy to overcome the entry barrier is to build a reputation by joining more established consortia and carrying out smaller work packages, while leaving coordination and 'agenda-setting' to more experienced entities.

Engagement in emerging niche areas can also help overcome market entry barriers as there may be less competition, and building a reputation at a national level can help increase confidence in their ability to deliver EU projects.

During the Validation Event on 12 September 2014 (at Europe House, Smith Square, Westminster, London) it was evident that Catapults have developed a range of different strategies, from on the one hand entering a number of bids in order to develop links and

build awareness in a well-defined market place, to engaging in policy discussions that can inform future activity.

3.2. Factor two: Strength of consortium

Forming a strong consortium is key for successful EU engagement. The strength of the consortium is twofold: the consortium should have strong partners capable of providing relevant contributions, and also provide opportunities to develop networks with researchers and industry that will form the basis for future collaboration.

Furthermore, when forming consortia, the Technology and Innovation Centres highlighted the importance of capitalising on long-term relationships and selecting partners in accordance with their capabilities and the specific requirements of the project. This highlights the long term commitment needed to develop such relationships and insights and the following sections discuss this aspect in more detail.

Evaluating the probability of forming a strong consortium

"I think what we try to do is look for the situation where we have the largest probability of success.

Quite simply, we give priority to those areas where we are good, we can make a difference, we have good partners - something which we are able to do well. We go for those activities where the probability of success is the highest."

Dr Unni Steinsmo, President and CEO, SINTEF Arctic Frontiers

3.2.1 Capitalising on long-term relationships

Forming long-term relationships both at employee and institutional level is essential for EU engagement. This is particularly the case for EU projects, as they are generally, as noted

Capitalise on long-term relationships with partners

"The solution is not easy. You can during public private-partnerships start knowing other possible partners; you can start writing proposals and try to meet others and try to set up a group. At the end of the day what is very good is to have a group of frequent collaborators who you are confident about, who you trust as they are good in some particular topics, and with whom you can be successful in one proposal and be successful in a follow-on proposal and so on. But how to start – this is not easy."

Mikel Emaldi, Business Development, Tecnalia

before, larger and more complex activities than national initiatives.

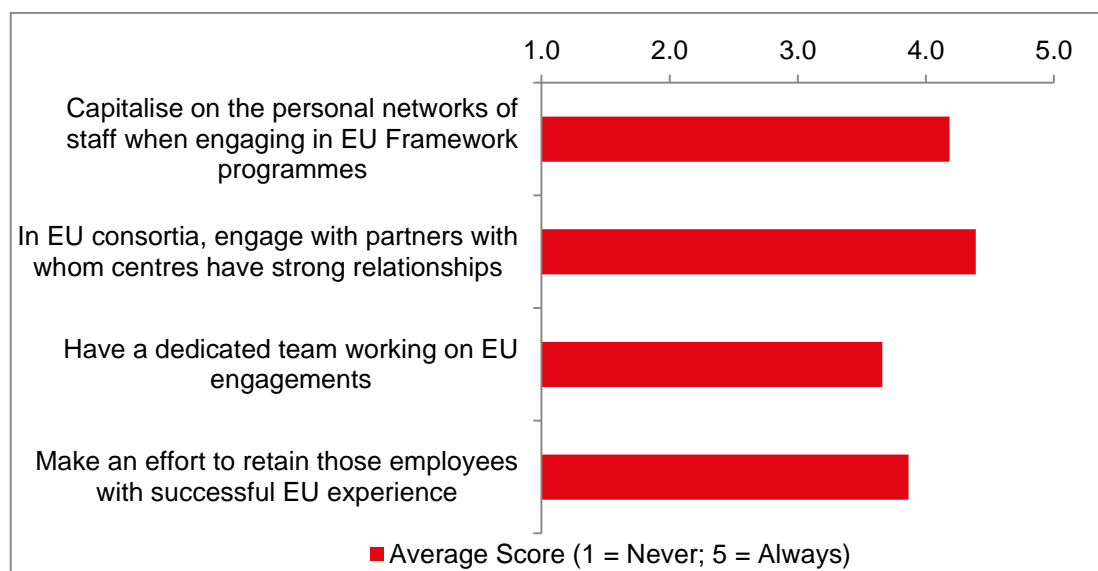
Technology and Innovation Centres are thus more likely to partner with institutions with which they have established a strong relationship and in whom they have confidence to deliver. The survey highlighted (see Appendix 2) the tendency

to capitalise on long-term relationships, to derive value from the projects.

As also shown in Figure 3.2, Technology and Innovation Centres appear to invest in forming

long term partnerships and seek staff able to build and manage useful networks. During the Validation Event, it was apparent that young Technology and Innovation Centres in particular, appear to invest time and resources to develop strategic networks and hire experienced employees with wider useful personal networks.

Figure 3.2 Capitalising on long-term relationships



In this context, Public-Private Partnerships (PPPs), European Technology Platforms (ETPs), and other such 'recognised' advisory structures, provide ideal fora to develop useful networks. Furthermore, engaging in national and industry funded projects provide a useful platform to develop new partnerships for subsequent EU engagement.

Build and manage new networks

"Networking – a lot of my work goes in this direction – meeting for conferences and workshops, meeting the other programme managers of the other institutes in Europe, building up a network so that you are immediately informed that something is going on. If a new project is set up for a call then make sure you are in the best consortium and not the second best. It is extremely competitive"

*Dr Stefan Glunz, Director – Division of Solar Cells,
Characterization Fraunhofer Institute for Solar
Energy Systems ISE*

Strategies adopted by Technology and Innovation Centres also include having a dedicated team working on EU engagement, making an effort to retain employees with successful EU experience and facilitating the mobility of staff between Technology and Innovation Centres, industry and academia. Supporting well trained staff at Technology and Innovation Centres to move to industry and academia – and vice versa -

widens Technology and Innovation Centres' network of contacts in the long run. However, newly established Technology and Innovation Centres such as the Catapults are more likely to place a premium on building up a critical mass of well networked employees in the short

term.

Furthermore, attending events, such as trade fairs and conferences, hosting events to promote activities, and dissemination activities ranging from academic publications to social media can also increase the ability of less established Technology and Innovation Centres to develop their networks and become members of project consortia.

Capitalise on long-term relationships with staff

“Certainly ensure that you have got dedicated staff to help, and staff who stay, because the worst thing is having one person who is linked to a project and learning from the EU tricks and skills, and then they finish and move on to the next job. [...] so it’s important to invest in people who will last from project to project”

Marie-Helene Pinard-van der Laan, Researcher, ICSA Carnot Institute for Animal Health

Raising awareness through conferences and publications

“The main point for us in that field on the academic side is to have a lot of publications on the important conferences; there are some European conferences where everybody who is in the field is there. You have to give good talks there, meet people there. The other thing is to have strong industrial projects. If you show good industrial impact, companies are interested to work with you on the next project; that’s also important.”

Dr Stefan Glunz, Director – Division of Solar Cells, Characterization Fraunhofer Institute for Solar Energy Systems ISE

Raising awareness through networks

“We try to be in the right communities and just send our people there. By doing, by showing, by reference. I think that’s the way to do it.

It’s not so much through traditional communications, in my opinion. You need to be known by others.”

Dr Leena Sarvaranta, Head of EU Initiatives, VTT Technical Research Centre

3.2.2 Strategic choice of partners

Three factors appear to come into play when Technology and Innovation Centres identify partners.

- Fit to the overall scope of the project - this covers specific capabilities and complementarities.
- Opportunity to generate future value. Most Technology and Innovation Centres develop bilateral relationships with companies after EU projects, and also, make use

of good contacts to engage in new projects.

- Reliability of partners as the quality of output delivered by partners is a major determinant of ultimate outcomes of EU projects.

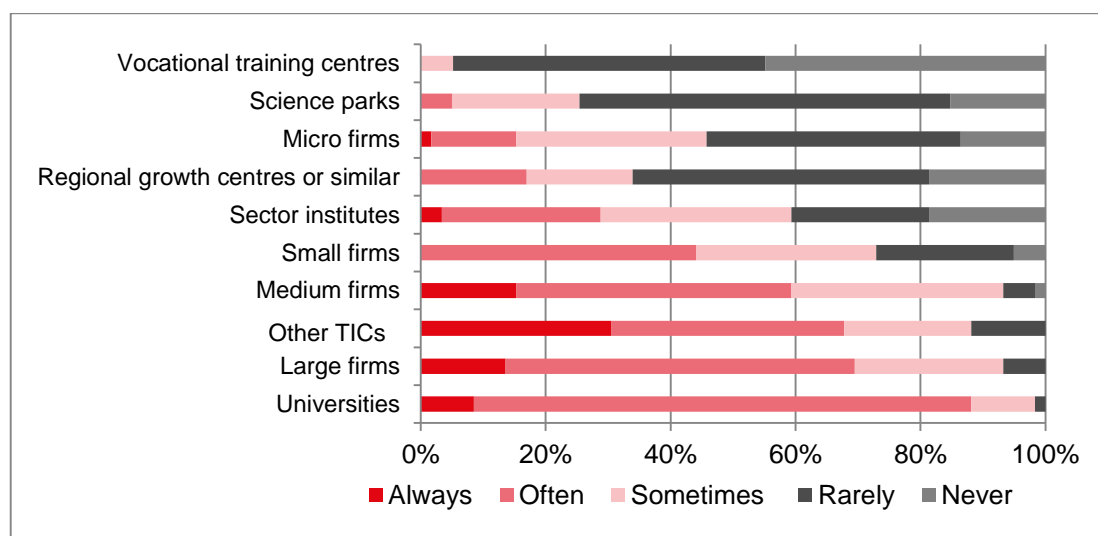
Selecting partners strategically

“It’s a failure if you just contact a partner like an SME or a smaller partner if you don’t have a good idea why you are contacting them besides the fact they are from the south of Europe and you are just looking for south European partners or because they’re an SME and you need a tenth SME. That’s not going to work out, so you have to have a good idea where people will fit in. A good project will be where everybody is important both alone and with the others; - ask what is he bringing in? It’s that match which is sometimes difficult to identify; once you’ve identified it then it’s great. What you have to avoid is the artificial participation of any partner.”

Marie-Helene Pinard-van der Laan, Researcher, ICSA Carnot Institute for Animal Health

Figure 3.3 provides an overview of the types of organisations Technology and Innovation Centres are likely to partner with when undertaking EU projects and the likelihood of such engagement.

Figure 3.3 Types of partners with whom Technology and Innovation Centres engage within EU projects



Our regression analysis (see Appendix 2) and in-depth interviews highlight specific criteria Technology and Innovation Centres should consider when engaging with these partners:

**Motivating industry to
engaging in EU projects by
VTT**

- 1. Sector based advisory boards are used by VTT as the means to encourage companies to engage in EU projects and to understand the needs of companies.*
- 2. We also raise awareness of EU opportunities through roadshows.*
- 3. VTT's communication teams educate companies through a wide range of media.*
- 4. We offer special professional support such as key account management for companies engaging in EU activities.*

*Dr Leena Sarvaranta, Vice
President EU Affairs, VTT
Technical Research Centre of
Finland*

- Universities - have structures that ease the transaction cost of EU engagement, and generally provide motivated individuals who can deliver. However, while the contribution of universities to research at lower TRLs is high, in the case of closer to market projects, it is important to ensure that their motivation and associated set of capabilities will add value.

- Large companies and SMEs will be reluctant to engage in EU programmes unless there is a clear alignment with their corporate strategies and priorities. When it comes to building the consortium, the size of corporate engagement could matter. An earlier survey of Technology and Innovation Centres in Europe revealed that especially smaller firms engage to overcome limited resources and that they are seeking more general support from concept to market, whereas larger firms are more likely to engage to accelerate innovation through more targeted services⁶ Furthermore, even when there is clear alignment, there may be bandwidth/competency issues that

compromise the ability of small firms in particular to engage. The close links of Technology and Innovation Centres to industry and their experience of engaging in EU projects can help overcome barriers to engagement, as illustrated by the VTT example below.

- Technology and Innovation Centres have similar cultures and motivations, which, as in the case of Universities, reduces transaction costs. However, there may be an overlap in capability, which makes it vital to carefully select Technology and Innovation Centre partners with complementary knowledge, expertise, resources, technologies and networks.

⁶ See Andersen and Le Blanc, E. (2013): Catapult to success: Be ambitious, bold and enterprising. Big Innovation Centre. Commissioned by the TSB, ESRC, and IET.
A Step Beyond: International Evaluation of the GTS (Global Technology Service) Institute System in Denmark. A consultancy contract of services for the Danish Ministry of Science, Technology and Development. Published by the Ministry, Copenhagen March 2009. International panel of five, including Birgitte Andersen and Rapporteur Erik Arnold, Technopolis.

The similarity between Technology and Innovation Centres sometimes makes it difficult to decide where they will fit in

“With other technology organizations the problem is working out which branch they fit in and which branch we fit in and trying not to do the same things, but to define our roles and their roles. In all cases, in all projects, we collaborate with technology organizations like us.”

*Mikel Emaldi, Business Development,
Tecnalia*

Easy to work with Technology and Innovation Centres since they have same interests and culture

“There are organisations like us in several countries around Europe and it's very beneficial to work with them because they have similar challenges. We share experiences, design plans, and collaborate on how to overcome challenges.”

*Dr Harri Kulmala, CEO, FIMECC Ltd.
(Manufacturing, Metals, and
Engineering SHOK)*

Seeking complementarity is essential

“Yes. Sometimes they [Technology and Innovation Centres] are so big they have similar competences, but we try to make a project where they provide a competence which is complementary to something else and not the same. It depends on the research and technology organization in question – they are working very differently in every country, but we have a lot of projects where we work together with others; VTT, TNO, from Spain also. It's working but it should be complementary. We also have some bad experiences with some organizations. They just wanted to learn what we know so that they can do it on their own afterwards and their contribution to the project was minimal, so that is also happening.”

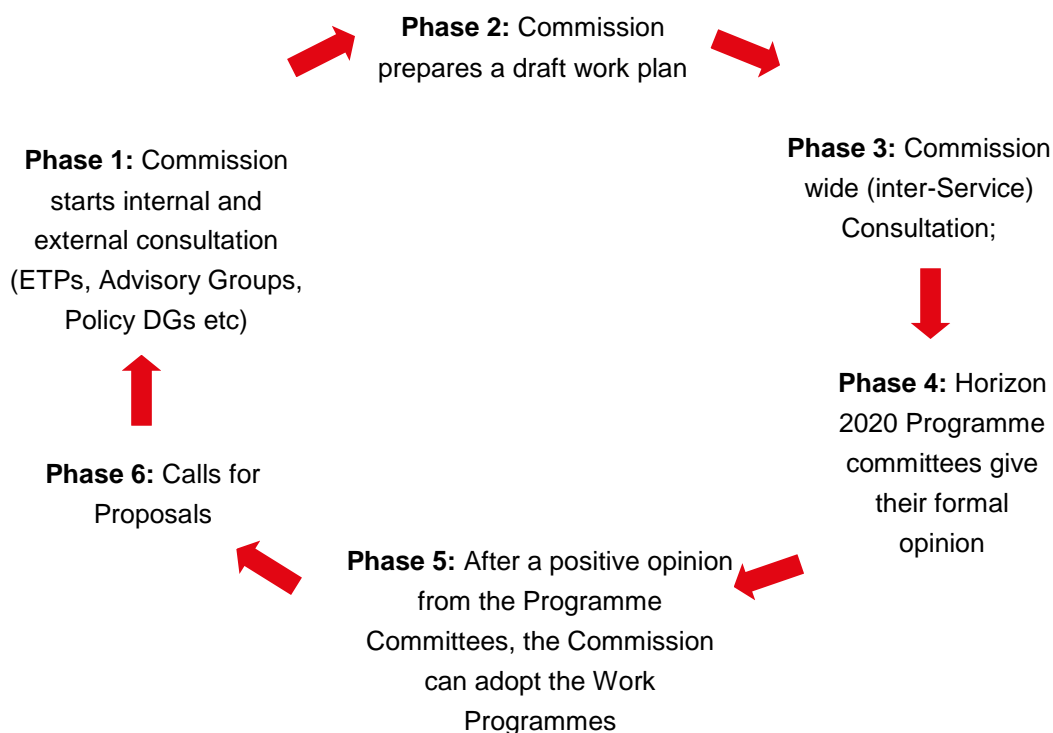
*Dr Karl-Heinz Haas, Managing Director, Fraunhofer Nanotechnology Alliance,
Fraunhofer ISC*

3.3. Factor three: Ability to influence

The European Commission (EC) consults widely to identify priority areas for investment. The assessments cover the scale of the market opportunity and the ability of EU industry to gain competitive advantage in these areas amongst other factors. The process by which the EC gathers evidence and informs its programme priorities is summarised in Figure 3.4.

Given their national role and associated strategies, state funded Technology and Innovation Centres are well placed to engage in these consultations, although their influence is reported to be greater when Technology and Innovation Centres work in partnership rather than individually.

Figure 3.4 EC adopts a structured process to seek input from stakeholders



But the EC's formal consultation process is not the only way Technology and Innovation Centres seek to influence EU policies and objectives. Figure 3.5 shows a whole suite of mechanism adopted by Technology and Innovation Centres. The figure illustrates the extent to which Technology and Innovation Centres use each of these modes to influence EU policies and objectives.

Collective actions are required

"We see more and more that one voice is often not enough so you need to be together, through a larger group or organisational forum, to influence EU policies."

Marie-Helene Pinard-van der Laan, Researcher, ICESA Carnot Institute for Animal Health

"It's difficult to impact as an individual organisation, but if you come as a set of national Technology and Innovation Centres from 15 different European countries, they tend to listen."

Jorn Rasmussen, Director R&D, DHI, GTS

It is quite apparent that sector specific networks, ETPs, high level advisory groups and PPPs are perceived to be the most influential as these also provide some subject matter focus.

Technology and Innovation Centres involved in writing EU calls

“As an example, the [existing] Factories of the Future PPP has a specific influence on the Factories of the Future PPP call for proposals [Horizon 2020] – they more or less write the call for proposals so in this case we have a fair amount of influence, but in other cases we have much less.”

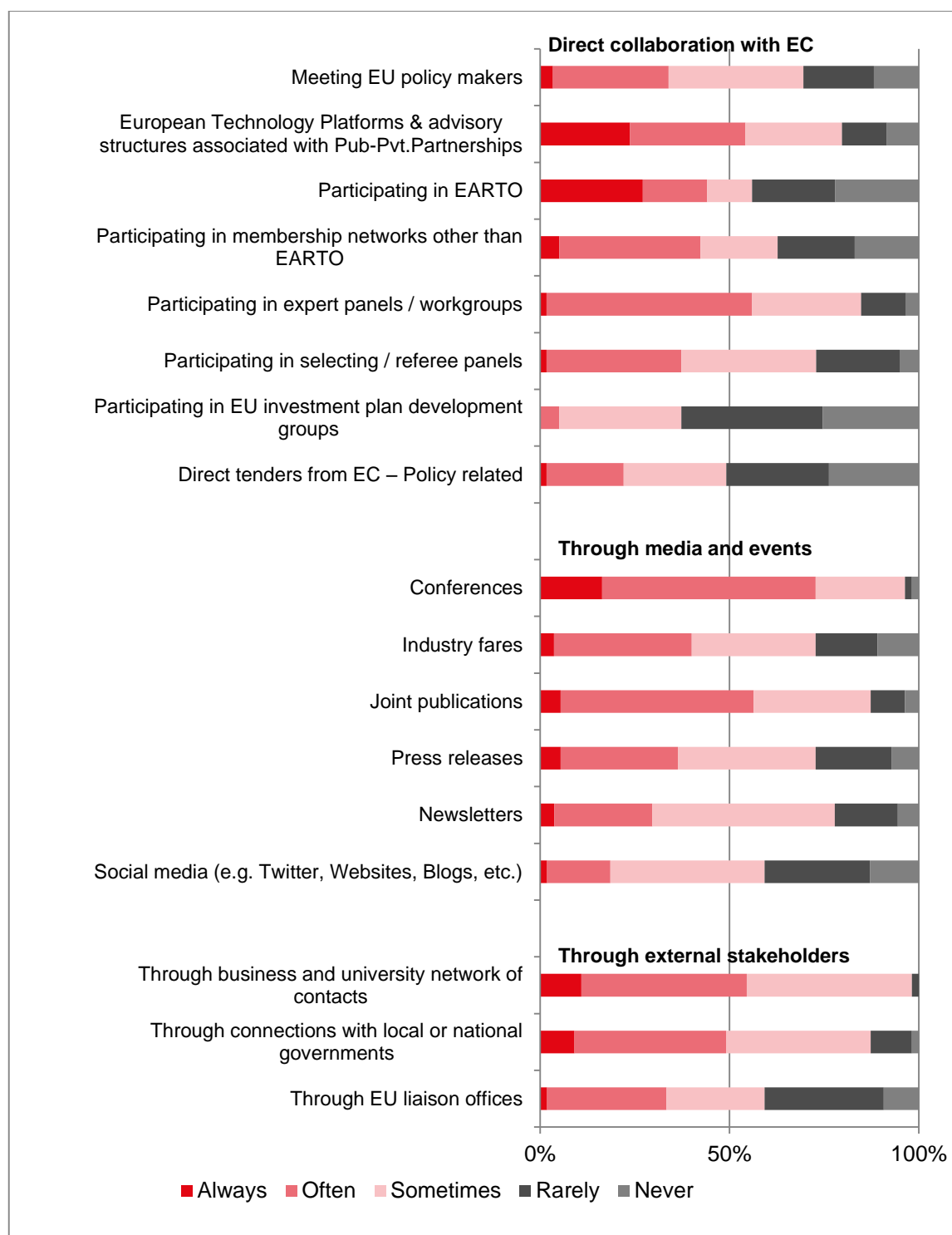
Mikel Emaldi, Business Development, Tecnalia

Box 7 – Key advisory structures utilised by Technology and Innovation Centres

- Contractual Public Private Partnerships (PPPs) are structured partnerships with the private sector which provide direct input into the preparation of the work programmes in areas which are defined upfront.
- Joint Technology Initiatives (JTI) – JTIs are institutional PPPs. These are legal partnerships between the Commission and industry where the EC and industry jointly fund research and innovation in pre-defined areas with an agreed budget over the duration of Horizon 2020.
- European Technology Platforms (ETP) – these are industry-led stakeholder fora that develop short to long-term research and innovation agendas and roadmaps for action at EU and national level. They are part of the ‘recognised’ external advisory structures to inform and oversee Horizon 2020, and importantly, all the current PPPs and JTIs originated directly from the work of one or more ETPs.
- Advisory Groups – these are independent expert groups that have been established to advise the European Commission (EC) on Horizon 2020 priorities. Experts come from public, private and civil society backgrounds.

Given the nature of participants in PPPs and ETPs, Technology and Innovation Centres also utilise these structures to develop strong European networks and potential consortia for future programmes.

Figure 3.5. Modes used by Technology and Innovation Centres to inform EU policies and objectives



Developing networks to influence EU should be done well in advance

"I would say that you need to be established in a group of good and familiar partners from other countries with which you are comfortable, and with whom you have success of course, but it is not going to be quick. Establishing networks and collaborating in some of the PPPs is a good step. It's a matter of getting the full list and select a few in which you would be more interested. It is not an easy task. You need to start working on them [gaining partners], start writing proposals and try to develop your experience."

Mikel Emaldi, Business Development, Tecnalia

Technology and Innovation Centres define their research priorities, through extensive engagement with, and an understanding of industry and wider policy needs, and their perception of future developments in their areas of focus, to inform their input to the development of EU priorities. This helps develop stronger synergies between EU and national activity.

As one would expect, the flow of information works in both directions - information gathered through European networks also guide national policies and Technology and Innovation Centres' strategies. For example, strategic research agendas developed by ETPs are also used by the Fraunhofer institutes and TNO to inform both their own and national policies and priorities.

Documents prepared for EU in turn influence national policies and the Technology and Innovation Centres' strategies

"These [the documents prepared by EU experts on request of EC to shape calls] are also used sometimes to develop national objectives because the EU documents bring together the expertise of a lot of experts from the European level, who foresee future needs and trends"

Dr Stefan Glunz, Director – Division of Solar Cells, Characterization Fraunhofer Institute for Solar Energy Systems ISE

Influencing EU is essential for EU project success

"So the long-term strategy is that our themes are in a pre-phase already engaged with the EU and helping define the objectives for the research agenda for the EU itself. If you do not do that, you will get too low a success rate. So you should invest in your EU network and being engaged in helping. It's not so much lobbying; it's really helping the EU in defining the right objectives for the research calls that will be put out maybe a year later".

Dr Erik Drop, Deputy Director of Strategy, TNO

Influencing EU policies helps Technology and Innovation Centres to get themselves prepared in advance

“The benefit of course is that you make an input in to this [ie EU policies], you know what to expect, you know if your recommendations are taken up, you are forewarned, you get prepared for what will be published in the calls and so forth.”

Moses Mengu, Director, International Centre, Danish Technological Institute (DTI), GTS

3.4. Factor four: Support services and access to funds

Most of the Technology and Innovation Centres – especially the larger ones – have a central support service. Their responsibilities vary, but generally they analyse EU calls and inform researchers of relevant calls and important information; actively engage in EU policy circles; identify opportunities for engagement; influence EU priorities; put researchers in touch with EU bodies and EC officials; provide researchers with support when developing proposals and carrying out EU projects (e.g. costing, administration and legal support); and promote knowledge exchange between researchers.

While smaller institutes within the GTS – Advanced Technology Group - outsource their support services, large Technology and Innovation Centres have their own centralised support system. Well established Technology and Innovation Centres have clear strategy on when to internalise or outsource their centralised EU support structures.

Table 3.1 provide examples of how six different Technology and Innovation Centres have organised their framework conditions for support services. While the arrangements are different from one Technology and Innovation Centre to the other, all appear to provide a similar set of services.

Technology and Innovation Centres work together to develop human resources

“We often collaborate with other Technology and Innovation Centre, for instance, with TNOs and Fraunhofers. We have very good relationships with them and often interchange researchers so we develop human resources and stronger networks through personal level involvements”

Guillermo Gil Aguirrebeitia, Director ICT Division - European Software Institute, TECNALIA

“We organize seminars or workshops with others Technology and Innovation Centres as Rendez-vous Carnot for instance. Some Fraunhofer institutes and VTTs also come to these sessions. These sessions are extremely important to exchange knowledge and develop relevant capabilities”

Jean Caelen, Laboratoire d'Informatique de Grenoble, Grenoble Institute of Technology, France

Table 3.1: Support services for EU engagements

Function	Fraunhofer	Carnot institute	VTT
1. EU influence	The 66 institutes pay for a common office in Brussels which has six people. They inform EU policies and make institutes aware of relevant policy developments. They also help the Institutes meet with key officials and gain insights into policy priorities.	EU influence, networking and call selections are carried out and support services are provided at individual institute level. E.g. <ul style="list-style-type: none"> One Carnot institute has a sister organisation, called INRA, which supports researchers; if a researcher is applying as a coordinator, one person is allocated to help and successful projects are provided with management support. CEA-Leti, which has 4000 staff, has 7 to 10 specialist staff directly engaged in EU activities, including lobbying (one or two people lobbying at the high level on specific research areas), analysing EU calls, providing the institute with up-to-date EU information and being a contact person between EU heads and the institute 	Chief Technology Officer's office, which is funded by the Ministry of Employment and Economy in Finland, is responsible for EU influence and dealing with strategic partnerships and strategic coordination and steering within VTT. EU team comprising 18 people help VTT to be part of cooperation with the Commission in relation to influencing framework conditions for calls, rules and funding criteria, etc.
2. EU networking			
3. Selection of EU calls through strategic alignment with the vision of the Technology Centre	This is done at the institute level	<ul style="list-style-type: none"> CEA-Leti, which has 4000 staff, has 7 to 10 specialist staff directly engaged in EU activities, including lobbying (one or two people lobbying at the high level on specific research areas), analysing EU calls, providing the institute with up-to-date EU information and being a contact person between EU heads and the institute 	EU team helps researchers for EU administration, accounting and auditing.
4. Support services (e.g. Administration, accounting, auditing, proposal writing)	<ul style="list-style-type: none"> The central administration office in Munich has an EU department, which provides general information about projects and supports proposal drafting in terms of economic calculations, while scientists write technical aspects. Institutes pay for the services received. Central support services help to find calls, but individual institutes also proactively search for calls and apply directly themselves. National contact points – review proposals for free 		A legal team of 4 to 5 people deals with legal aspects of proposal preparation and agreements.
5. Knowledge exchange and training	<ul style="list-style-type: none"> EU project network within Fraunhofers – open innovation network within the institute who channel the information from Brussels, evaluate this information, and present useful information. The group meet twice a year and exchanges knowledge on how to succeed in EU projects. Some networks are theme specific. Internal Fraunhofer webserver, which shares information on EU engagements and presentations of the colleagues who presented at EU meetings. 	National Association of Carnot institutes organise seminars and workshops for Technology and Innovation Centres in order to help prepare projects.	Chief Technology Officer's office provides training in relation to EU engagements. An internal VTT network consists of EU coaches (who are experienced researchers) and young researchers. This network/ community meets once a month. They exchange knowledge on EU policies, Horizon 2020 and the value chain etc., collaboratively develop projects and competencies, and help each other to sort out issues.

Table 3.1: Support services for EU engagement

Function	SINTEF	TNO	Tecnalia
1. EU influence	Central support system attempts to influence EU policies and engages in relevant networks	One person per theme is appointed for EU engagement. This person's tasks are to: <ul style="list-style-type: none"> • In collaboration with other researchers decide the level of EU funding required to achieve the road map, which directs each theme and is sometimes also changed to accommodate some important EU calls. • Work on a regular basis in Brussels as well as the Netherlands, and attend scientific and consortia meetings • Actively engage in the EU to define calls • Connect, researchers with EU and the European Commission • Identify and send relevant calls to researchers 	Central structure supports all 7 Tecnalia centres.
2. EU networking			Carried out by EU teams of individual Tecnalia centres. Once they are informed by the central administration about EU calls, these teams filter EU calls on the basis of strategic alignment with the objectives of individual centres.
3. Selection of EU calls through strategic alignment with the vision of the Technology and Innovation Centre			
4. Support services (e.g. Administration, accounting, auditing, proposal writing)	Central support services provide administration, cost related and other services for those engaged in EU projects		Central support service supports all 7 Tecnalia centres.
5. Knowledge exchange and training	Researchers are provided with project management training and opportunities for knowledge exchange		

The nature of the support structures have evolved with improved access to information and transport links. For example, TNO only have a single member of staff based in Brussels, while the Fraunhofer Institute's Brussels office focuses on cross-cutting issues such as framework conditions.

At present in the UK, the need for centralised support structures appears to depend on the relative maturity of the Catapults. Established centres see greater value in fora to share best practice, whereas others see benefit in having access to central support structures until they can bridge their experience gap.

Key areas where discussion and an opportunity to share best practice would be welcomed by Catapults included (i) sharing what works well in EU projects including the interpretation of rules and up to date information, (ii) influencing EU activities (iii) exchanging knowledge on financial and administrative aspects (iv) strategic engagement and (v) operational and legal matters.

The importance of framework conditions is best illustrated through the efforts of the European Association of Research and Technology Organisations (EARTO), which helped redefine the treatment of direct and indirect costs. In its absence, the aid intensity would have compromised the ability of Technology and Innovation Centres to engage in EU projects.

Informing EU on how to improve the cost structure

"The EU has introduced a new cost structure for Horizon 2020 in which applicants are only allowed to claim 25 per cent of their indirect costs but they could get 100 per cent of their direct costs reimbursed. This change in relation to indirect costs results in a reduction of the total average funding from 75 per cent in FP7 to about 60 per cent in Horizon 2020 and so prompted EARTO and some Technology and Innovation Centres to influence the EC. As a result, the policy was changed so that Technology and Innovation Centres could transfer some of the indirect costs such as infrastructure investments to direct costs provided that they could justify the association between these costs and direct costs (e.g. the cost of electricity for employees working on EU projects). These transferred costs will be fully reimbursed, which may reinstate the previous level of cost recovery"

Talita Soares, Policy Officer, EARTO

"The first ones who were really alarmed were VTT and TNO, then Fraunhofer, then SINTEF and then CEA and Tecnalia..... We started to cooperate immediately and set up a taskforce within EARTO, a taskforce on financial issues.

We had a core group of certain Technology and Innovation Centres and then loads of other Technology and Innovation Centres taking part in various meetings...Now we are finalising a solution together with the Commission where we could claim infrastructure spending as direct costs and get 100% refunded."

Dr Leena Sarvaranta, Vice President EU Affairs, VTT Technical Research Centre of Finland

The availability of core funds to invest in the development of future capability via EU funds and incentives such as those provided to the Fraunhofer Institutes (institutes attract 15 cents of additional state funding for every €1 of EU income they secure) can also facilitate engagement as Technology and Innovation Centres cannot recover the full cost of their engagement in EU projects.

Financial and broader resource constraints will be particularly pronounced for smaller and less established Technology and Innovation Centres. This highlights the importance of core funding provided by governments in order to ensure that Technology and Innovation Centres have sufficient funds to co-invest in EU projects which generate wider benefits and cascades broader social and economic impacts in terms of economic growth and job creation. Such public funds are useful to de-risk private investments in high risk but essential projects, which are unlikely to occur otherwise.

Value creation should go beyond financial gains

"There is a tendency of not putting a price on the competence development that you achieve, so you tend not to put a monetary value on the knowledge that you built. You just measure value in turnover. You should properly appreciate the knowledge that actually develops in the projects. It tends to be underestimated. If you could make a model that takes in to account the value creation of these EU projects besides just the expenses that you cover, maybe it will look better in the cost benefit analysis."

*Asser Kalsboll, Business Development Manager,
DELTA, GTS*

Gauging the return on investment of core-funding

"The Fraunhofer Institute has basic funding from the state, say 20%. The rest we have to raise – half directly from industry and half from public funds in competition, like an EU project and of course projects where we have to make our own financial contribution. We always have to think how to spend that very limited core funding. We have to contribute co-financing for EU projects or other projects from very limited basic funding that we could also use for investments in in-house projects, or to maintain or improve expertise in certain fields, or even to save some money for other times."

*Prof Dieter Hofmann, Head of Strategy and Marketing Department, Fraunhofer
Institute for Applied Polymer Research IAP*

3.5. Factor five: Stable and proactive government actions

Unexpected changes in national policies that conflict with EU policies and where uncertainties are created around state funding will negatively impact on the ability of Technology and Innovation Centres to engage in EU activities. Since engaging in EU projects is a long-term investment, stability and certainty in national government policies play a major role.

Unexpected changes in government policies negatively influence EU engagements

“When the Spanish offshore wind guidelines, which changed, this caused a Spanish (corporate) partner to decide that it doesn’t make sense for us to make offshore wind turbines any more, so they withdrew from all the projects pertaining to that topic. Now the project is probably dying. The industry partner is typically lethal to a project, especially since they typically contribute a very large amount of money. It is of course hard to recover [equivalent funding] when they withdraw.”

Arno van Wingerde, Business Leader -Research, Fraunhofer IWES

For example, the uncertainty regarding the continuation of government funding for Carnot institutes after 2016 is reported to have negatively affected their EU engagement since long-term commitments in EU projects requires internal funding stability (See section 2.1 on complementarities between EU and government funding).

A national government which is not proactive but is more departmentalised and narrow is also identified by some Technology and Innovation Centres as inhibiting successful EU engagement. Since most of the Technology and Innovation Centres are formed to follow the national mandate, if the government is slow at implementing decisions taken at EU level it can negatively affect a Technology and Innovation Centre’s ability to successfully reap the benefits from engagement in EU activities.

HOW: Factors which lead to successful EU engagement by the Technology and Innovation Centres

Catapults should have a long-term vision and strategy for EU engagement. Five main factors that govern the successful EU engagement by Technology and Innovation Centres are:

Factor one

- The extent to which the strategy for EU engagement aligns with the strategic direction and expertise of the Technology and Innovation Centre

Factor two

- The likelihood of forming a strong consortium

Factor three

- The ability to gain insights from, and shape the strategies of, EU objectives and policies

Factor four

- Sufficient availability of support services for EU engagement

Factor five

- Stable and proactive government actions

Appendix 1: Indicators used as evidence base captured via online survey and interviews

The following tables from (A) to (F) illustrate different variables covered in the online survey and table (G) presents themes covered in in-depth interview questionnaires.

TABLE A

Organisational Characteristics	Variables	Measurement
Initiative	<ul style="list-style-type: none"> • Carnot (France) • Fraunhofer (Germany) • GTS (Denmark) • Leibniz (Germany) • SHOK / TEKES (Finland) • SINTEF (Norway) • Tecnalia (Spain) • TNO (Netherlands) • VTT (Finland) 	Tick boxes as appropriate
Geo-Demographic Characteristics	<ul style="list-style-type: none"> • Area of specialisation • Postcode • Number of employees • Number of employees in EU operation (or Fulltime Equivalent) • Number of employees permanently located in Brussels • Age of the organisation • Years of experience in EU operation • Average annual turnover of your organisation during last three years • The composition (%) of turnover on the basis of source (EU Framework Programmes, Other EU Programmes, International programmes (non EU), Local / national government and Industry) 	State exact values

TABLE B

Targets and Success	Variables	Measurement
Target	<ul style="list-style-type: none"> • Organisations' targeted proportion of revenue from EU Framework Programmes 	Percentage
Success	<ul style="list-style-type: none"> • Number of EU Framework Programme projects applied for during the last three years • Number of EU Framework Programme projects won during the last three years 	Number of EU Framework Programme projects

TABLE C

Motivations to Engage in EU Projects	Variables	Measurement
Research related	<ul style="list-style-type: none"> Engage in basic research Engage in applied research Develop new equipment and technologies Develop your organisations research streams Produce intellectual property (e.g. patents) 	Likert scale of 1- 5: 1- Strongly disagree 2- Disagree 3- Neither agree nor disagree 4- Agree 5- Strongly Agree
Knowledge related	<ul style="list-style-type: none"> Access new and advanced knowledge Access knowledge from other discipline Transfer knowledge to industry 	Above stated Likert scale of 1-5
Market related	<ul style="list-style-type: none"> Access global markets Develop products and services Help industry to access international markets Help industry to pursue their goals 	Above stated Likert scale of 1-5
Finance Related	<ul style="list-style-type: none"> As a source of revenue To minimise risk 	Above stated Likert scale of 1-5
Resource or capability related	<ul style="list-style-type: none"> Develop new research based capabilities Develop new management capabilities Develop new physical infrastructure for the organisation (e.g. lab facilities, and equipment etc.) Develop expertise on successful EU engagements 	Above stated Likert scale of 1-5
Strategic Networking related	<ul style="list-style-type: none"> Develop networks of future value Be active in the EU Demonstrating social value 	Above stated Likert scale of 1-5
External influences	<ul style="list-style-type: none"> Push by local / national government Push by the head office Push by the EU liaison office Push by shareholders 	Above stated Likert scale of 1-5

TABLE D

Approach for EU Projects	Variables	Measurement
Technology Readiness Levels the organisation is most likely to engage in EU	<ol style="list-style-type: none"> 1. Concept proposed with scientific validation 2. Application and validity of concept validated or demonstrated 3. Experimental proof of concept completed 4. Production validated in lab environment 5. Basic capability demonstrated 6. Process optimised for production rate on production equipment 7. Capability and rate confirmed 8. Full production process qualified for full range of parts 9. Full production process qualified for full range of parts and full metrics achieved 	Tick box/es as appropriate
Approach for EU engagement	<ul style="list-style-type: none"> • Technology push – Co-creation • Technology push – Transfer • Market pull – Co-creation • Market pull – Transfer 	Tick box/es as appropriate
The nature of contribution to EU projects	<ul style="list-style-type: none"> • Act as a coordinator • Bring partners to the consortium through own networks • Conducting basic research • Conducting closer-to-market research • Developing technologies • Providing resources (e.g. machinery, equipment, etc.) • Providing services such as testing, calibrating and implementation of certification (e.g. ISO) • Providing services such as training • Not a partner, but a sub-contractor (e.g. consultancy and sales) 	Likert scale of 1- 5: 1- Never 2- Rarely 3- Sometimes 4- Often 5- Always
Partners in EU consortia	<ul style="list-style-type: none"> • Universities • Large firms (over 250) • Medium firms (50 – up to 250) • Small firms (11 – up to 50) • Micro firms (Up to 10) • Other Research and Technology Organisation • Science parks • Regional growth centres or similar • Sector institutes • Vocational training centres • Other 	Likert scale of 1 - 5: 1- Never 2-Rarely 3-Sometimes 4-Often 5-Always

TABLE E

The Influence of Practices	Variables	Measurement
Capability Related	<ul style="list-style-type: none"> • Have a portfolio of employees with different skills (e.g. basic research, applied research, management, etc.) • Develop core competencies in a specific area • Make an effort to retain those employees with successful EU experience • Exchange staff between organisations / universities / industry to acquire new knowledge and skills (i.e. placements) • Have a dedicated team working on EU engagements • Have a premise in Brussels • Have staff located in Brussels on a permanent basis 	Likert scale of 1-5: 1- Extremely unlikely 2- Unlikely 3- Less likely 4- Likely 5- Extremely likely
Engagement Related	<ul style="list-style-type: none"> • The involvements in EU Framework Programmes are initiated by individual employees • Your organisation's staff has freedom of deciding their EU engagements (e.g. what to engage in, with whom to engage in, how to engage in etc.) • Your organisation has freedom of deciding its EU engagements (e.g. what to engage in, with whom to engage in, how to engage in etc.) • Use a pragmatic approach when deciding how to contribute to EU consortia • In EU consortia, engage with partners from different disciplines • Use EU framework programmes as a pathway to achieve your organisations' strategic goals • Influence EU policies and objectives • Engage in bilateral relationships with some partners of the EU consortia after EU projects (e.g. to further develop outputs) 	Likert scale of 1-5: 1- Extremely unlikely 2- Unlikely 3- Less likely 4- Likely 5- Extremely likely
Strategic Networking Related	<ul style="list-style-type: none"> • Capitalise on the personal networks of staff when engaging in EU Framework programmes • In EU consortia, engage with partners with whom you have good relationships • Use cross EC networks such as ERRIN to find potential partners • Develop relationships with key business players in the market • Develop relationships with local/national government • Develop relationships with universities • Develop relationships with European Commission 	Likert scale of 1-5: 1- Extremely unlikely 2- Unlikely 3- Less likely 4- Likely 5- Extremely likely

TABLE F

Modes used to Influence EU Activities	Variables	Measurement
Direct collaborations with EC	<ul style="list-style-type: none"> • Meeting EU policy makers • European Technology Platforms and advisory structures associated with Public Private Partnerships • Participating in EARTO • Participating in membership networks other than EARTO • Participating in expert panels / workgroups • Participating in selecting / referee panels • Participating in EU investment plan development groups • Direct tenders from EC – Policy related • Trade associations 	Likert scale of 1- 5: 1- Never 2- Rarely 3- Sometimes 4- Often 5- Always
Through media & events	<ul style="list-style-type: none"> • Conferences • Industry fares • Joint publications • Press releases • Newsletters • Social media (e.g. Twitter, websites, blogs, etc.) 	Likert scale of 1- 5: 1- Never 2- Rarely 3- Sometimes 4- Often 5- Always
Through external stakeholders	<ul style="list-style-type: none"> • Through your business and university network of contacts • Through connections with local or national governments • Through EU liaison offices 	Likert scale of 1- 5: 1- Never 2- Rarely 3- Sometimes 4- Often 5- Always

TABLE G

Variable	Measurement
Benefits derived through EU engagement	<ul style="list-style-type: none"> • Why do you engage in EU activities? • What additional benefits could you gain through EU projects and funding when compared to national and industry activity? • Do you – generally speaking – achieve your objectives? • Which ones are harder to achieve?
Return on investment through EU engagement	<ul style="list-style-type: none"> • In your experience, are your time and resource investments on EU activities worthwhile and how do they complement and compare to those with industry or national or regional sources (if the government funding is on competitive basis) (interviewer – obtain a comparative score – less, same or higher)? Why? • How would you rate EU activities on a scale of significance relative to the other business undertaken by a Technology and Innovation Centre?
Prioritisation of EU and other Technology and Innovation Centre activities	<ul style="list-style-type: none"> • How do you decide which activities you do on which level, and how do you prioritise different activities (e.g. EU, national and regional activities)? • What criteria do you use for this prioritisation? WHY THIS CRITERIA? • In your experience, how effective are such prioritisation mechanisms?
Target revenue from EU activities	<ul style="list-style-type: none"> • Do you have a target for how much revenue comes from EU activities? • Who decides this and how, and why?
Resource allocation for EU engagement	<ul style="list-style-type: none"> • Do allocate specific resources (e.g. physical, human and financial, specific support staff) for EU activities? • What criteria do you use for this resource allocation? Why this criteria? • What are the lessons learnt? (interviewer – the main aim is to understand resource allocation between EU activities and other national and industry activities)
Influencing EU policies and objectives	<ul style="list-style-type: none"> • To what extent do you seek to influence EU policies and priorities (Funding, Social and Economic)? • If so, Why (interviewer – direct the interview to check whether they seek to influence in order to achieve strategic objectives, increase the impacts of Technology and Innovation Centres' work and/or to increase the chances of future success of EU framework programmes)? • What modes do you use? • Why do you use these modes, and which do you find most effective (interviewer – on the basis of the motive, identify which modes are suitable to achieve each type of objective)?

Variable	Measurement
Barriers for engagement	<ul style="list-style-type: none"> • What are the barriers you confront when engaging in and influencing EU activities • How do you overcome these barriers? (interviewer – if the respondent mentions engagement with SMEs as a barrier further explore this)
Raising awareness	<ul style="list-style-type: none"> • [Particularly for young Technology and Innovation Centres] How do you raise the awareness of your capabilities and interest to potential partners of EU activities, including business and academia? • What challenges do you perceive or have encountered in your awareness-raising measures?
Working with partners in EU activities	<p>Questions based on the findings of previous data gathering stages</p> <p><i>We found that nearly all Technology and Innovation Centres were likely to partner with i) universities; ii) large firms; and, iii) other Technology and Innovation Centres in EU Framework Programmes.</i></p> <ul style="list-style-type: none"> • How well have you worked ON A SCALE OF 1-5 with these three types of organisations in EU Framework Programmes? • What lessons in terms of good practice and overcoming obstacles and challenges can be learned?
Innovation approach	<ul style="list-style-type: none"> • Which innovation approach/es would explain your engagement in EU activities (1/2/3/4)? <ul style="list-style-type: none"> ➤ Technology-push – Co-creation ➤ Technology-push – Transfer ➤ Technology-pull – Co-creation ➤ Technology-pull – Transfer • What challenges do you face when adopting the specific approach/es and how do you overcome these challenges?
Additional information	<ul style="list-style-type: none"> • What additional advice would you give to a Technology and Innovation Centre on how to successfully engage in EU activities, particularly in terms of good practices and strategies to overcome challenges?

Appendix 2: Regression Analysis

A regression analysis was carried out to investigate the factors that govern four types of benefits generated by Technology and Innovation Centres in EU projects, namely, Knowledge and capability, Market, Networking and Financial value. Four variables were developed by combining a number of benefits highlighted in Appendix 1. Similarly, of the independent variables, Practices adopted, Nature of contribution by Technology and Innovation Centres for EU activities, and Modes used by Technology and Innovation Centres to influence EU objectives and policies are generated by combining separate variables (highlighted in Appendix 1) through cluster analysis.

Independent variables	Dependent Variable			
	Knowledge & capability	Strategic networking	Market	Financial
R² and Adjusted R²	0.920, 0.769	0.842, 0.542	0.917, 0.759	0.942, 0.833
Characteristics of the Technology and Innovation Centre				
Size of the Technology and Innovation Centre	.000	-1.152E-005	.000	134487
Number of employees in EU engagement	.001*	.000	.001	1125789
Age of the Technology and Innovation Centre	.004	-.006	-.003	-8696747
Experience in EU activities	.003	.015	.021	55398365*
Turnover of the Technology and Innovation Centre	-7.208E-010	6.210E-010	4.541E-010	7.145*
Innovation Approach				
Technology push	-.178	.151	-.122	-404539897*
Technology Pull	.089	.079	-.015	-109180841
Co-creation	-.161	-.578*	.126	-181747587
Practices adopted				
Capitalising on long term relationships	.206*	.303*	.344*	319393876*
Developing new relationships	.270*	.203	.074	416693313*
Developing competencies	.102	.079	-.123	187184638
Accessing New external knowledge	.030	.240*	-.110	325430406*
Freedom of decision	-.246*	-.213*	-.199*	-229562959
Nature of contribution by Technology and Innovation Centres for EU activities				
Applied Research and Technology Service Provision	-.112	-.171	.213*	-62241337
Act as a Networking Agent	-.009	.013	.306*	307285028
Engage in Basic Research and Training	-.046	-.118	-.036	71977727
Modes used by Technology and Innovation Centres to influence EU objectives & policies				
Direct EU involvements and memberships	.263*	-.033	-.359*	-261298019
Written communication	.339*	.294	-.377*	-296184329
Expert advisory groups	.182*	.248*	-.045	-364899313*
Through external bodies	.334*	.275*	-.155*	-160238138
Media events	-.151*	.101	-.136*	-129723798
Partners with whom Technology and Innovation Centres interact with in EU projects				
Universities	.439*	.232	-.424	-487843869*
Large Firms	-.237	.008	.193	777892102*
Medium Firms	-.172	-.180	.032	-332097697
Small Firms	.073	.301*	-.210	-94742676
Micro Firms	-.250*	-.327*	-.052	28851126
Technology and Innovation Centres	-.339*	-.412*	.033	-258590200
Sector of operation of Technology and Innovation Centres				
Information and Communication Technologies (ICT)	-.455*	.060	.211	9320328
Bioscience (Agri, Chemical and Env)	-.144	.231	.038	-394735995
Engineering and Energy	-.476*	-.133	-.002	-80915995
Multi-sector	0 ^a	0 ^a	0 ^a	0 ^a

The Knowledge and dynamic capability, Market, Networking benefits are significantly correlated. Hence, MANOVA was used, since it takes into account interactions between dependent variables. A separate Univariate analysis was conducted for the financial benefits.

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