BUSINESS
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THE BIG THREE – IMPACT STUDY OF RESEARCH ORGANISATONS, LARGE ENTERPRISES AND SHOKS

IMPACT STUDY

Kalle A. Piirainen (ed.), Kimmo Halme,
Anne-Mari Järvelin, Torbjörn Fängström,
Hanna Engblom, Anne Mensink and Tomas Åström

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The authors:

Kalle A. Piirainen (ed.), Kimmo Halme,
Anne-Mari Järvelin (4FRONT),
Torbjörn Fängström, Hanna Engblom, Anne Mensink
and Tomas Åström (Technopolis Group)

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CONTENTS

FOREWORD

Innovations produce new information, competence and spillovers to benefit the entire society in the long run. Competence created through public funding spills over when employees change jobs, as companies cooperate other companies and research institutes, and as innovations build upon previous innovations.

A goal is that cooperation between universities, research institutes and companies creates expertise and spillovers that accumulates corporate innovation activities in Finland. Large companies play a key role, because research and the networking with large companies create competitive advantages.

Tekes (nowadays Business Finland) has advised researchers to take a role in business life as visionaries whose research results create preconditions for new business operations. Therefore, research projects has been funded, which has significant novelty value. The research has focused on the fields as technology, services, business or working life. The funding has emphasized extensive projects with close international cooperation that bring together research groups and company needs.

In this impact study, the purpose was to produce both ex-post and forward-looking impact analysis of research, large company and SHOK-projects. Data used in this study include Tekes-funded projects that ended during 2012-2017. Evaluation found answers to the three main questions. Firstly, how Business Finland (ex-Tekes) funding and activities for research organizations and large companies have succeeded to develop new platforms, and in recent years to ecosystems in the Finnish innovation environment? Secondly, how R&D&I funding and services have improved the utilization of research results in renewed companies and fostered competitive advantages of new business areas in the Finnish economy? Thirdly, what is the impact of public R&D&I funding for research organizations and large companies overall in the Finnish economy and society? Main finding of the evaluation was that Tekes-funded projects have more apparent and broader benefits for ecosystem building, networking and collaboration together with developing really new solutions and opening or addressing new markets.

This impact study was carried out by the evaluation team from 4Front Ltd and Technopolis Group. Business Finland wishes to thank the writers for their broad and systematic approach. Business Finland expresses its gratitude to steering group and all others that have contributed to the study.

Helsinki, April 2019

Business Finland

EXECUTIVE SUMMARY

STUDY OBJECTIVES

The objective was to study the impact and the role of Tekes and later Business Finland in fostering co-operation between actors within the innovation system and contribution to formation of network and ecosystems, and society in general. The main questions are:

1. How Business Finland (Tekes) activities for research organisations and large enterprises have succeeded in developing new platforms, and in recent years to ecosystems in the Finnish innovation environment?
2. How research, development and innovation (RDI) funding and services have improved the utilisation of research results in renewed enterprises and fostered competitive advantages of new business areas in the Finnish economy?
3. What is the impact of public RDI funding for Research Organisations (ROs, including universities, colleges and public research institutes) and large enterprises overall in the Finnish economy and society?

The study findings are based on the following data and methods:

- **Literature study:** Review/survey of literature on development of ecosystems. Also, study of documents related on Tekes/Business Finland strategy and funding.
- **Data / statistical analysis:** Analysis of Tekes funding data from projects ending between 2006 and 2017 and R&D statistics
- **Survey:** A web survey sent to 2700 contact persons of projects ended by 2016 from the three main focus groups of beneficiaries. The total number of individuals responding to the survey were 136 for the mail-group Large Companies, 212 for Research Organisations and 42 for SHOKS.
- **Case studies:** Case study including interviews, document and archival analysis related to ten cases of funded projects, four led by large enterprise, three by ROs and three SHOKs.

TEKES ACTIVITIES HAVE SUPPORTED THE FORMATION OF STABLE PARTNERSHIPS, PLATFORMS AND ECOSYSTEMS

The data suggest quite clearly that Tekes activities for research organisations and large enterprises contribute to formation of stable networks and ecosystems. When entering the projects, more than half of enterprises and 4/5 research organisations aimed to increase collaboration with (other enterprises), and approximately the same numbers found this to be an outcome of the projects. More than 3/4 enterprises and 4/5 research organisations also report lasting networks and partnerships were an impact of Tekes funding. Further evidence for the contribution is strengthening or development of capabilities among domestic subcontractors that was reported in approximately 3/4 of enterprise projects.

The research projects have been rather product oriented and approximately half have created technology demonstrations and pilots and have fleshed out business cases for exploitation of the results. As more systemic effects, the interviewees report that Tekes activities have had a key role in the in initiating and funding applied and industrially relevant research in areas that do not have an established industry or business area and that fall between academic disciplines or are in otherwise difficult position. The research projects also have offered a platform for dialogue between industry, researchers, policy makers and regulators and users or consumers that facilitate creating changes in attitudes and systemic changes. These research projects have also highlighted entirely new potential business areas and created research programmes and platforms. Research and RDI projects commonly continue into further RDI, they have attracted incumbents to new areas and also contributed to spin-offs and start-up activity.

The overall additionality or leverage of Tekes funding is the clearest and pronounced in larger, longer running and trailblazing projects. These projects have more apparent and broader benefits for ecosystem building, networking and collaboration together with developing really new solutions and opening or addressing new markets

BIG THREE COLLABORATIVE RESEARCH PROJECTS BUILD COMPETITIVE ADVANTAGE THROUGH TRANSFER OF KNOWLEDGE AND DEVELOPING NEW CAPABILITIES

While larger projects tend to have more systemic additionality, the more 'traditional' Tekes projects that address a specific need, have a clear focus and limited consortium do add value to R&D and help renew organisations and their processes and practices. The case studies illustrate that large enterprises' projects are goal oriented and focused on developing technology and products and/or services down the line. Typical added value is that Tekes funding has had a risk-sharing function and it enables taking on riskier projects, raise ambition and scope/depth of development. Stereotypically Tekes-funded projects are more ambitious, complex and more profound, and projects create knowledge, compet-

itiveness advantage, as well as new and improved products and services, and IPRs.

Additionally, expertise in funding agency lowers the bar for entering into new areas, and Tekes experts have added value into the process in helping highlight technological options and possible partners, and by helping evaluate them. As less tangible but very much related to renewal, Tekes funded projects have helped find new collaborations and evaluate new technological and business options, as well as helped build 'an innovation culture' and developing new ideas and practices.

The interviewees also recognise the value of the SHOK programmes in particular as an effort to build trust and a culture of collaboration between the various actors. The added value of large collaboration efforts specifically includes cultural change and also contributions to standardisation. The large programmes are also an opportunity to invest in standards development other major efforts that would not be (as) feasible in other settings.

THE DATA CONFIRMS THAT FUNDING FOR LARGE ENTERPRISES AND RESEARCH ORGANISATIONS CONTRIBUTES TO THE RENEWAL OF INDUSTRY, INNOVATION AND GROWTH

The majority of enterprises and almost all research organisations representatives report that the projects would not have been completed without the granted funding. Most respondents also report that the lowering of Tekes budget and associated changes in funding have negatively affected R&D volume and ability to conduct R&D in general, and collaboration in particular.

As discussed above, the projects contribute to renewal of individual enterprises and building of ecosystems. Typical impacts are lasting networks or clusters between research organisations and enterprises (more than 3/4 of respondents), technology transfer within industry (more than 3/4 or research organisations and over half of enterprises), improved consumer product or service (2/3 of respondents) and strengthened subcontractors (approx. 4/3 enterprises and slightly less than half of research organisations). In the long term, 4/5 enterprises also have or expect to experience increase in competitiveness compared to foreign competitors, as well as profitability and turnover. These impacts are trailed by increase in employment, exports, and competitiveness compared to domestic rivals, as well as development of new partnerships.

Overall, Tekes activities for large enterprises and research organisations have Input additionality at three levels. *At the Enterprise level:* risk sharing enables developing more uncertain and really new projects and enables developing them in a more profound fashion. *At the Ecosystem level:* the projects have created new network connections and facilitated collaborations, created joint understanding of technology and end-user needs

At the Knowledge level: the projects have created knowledge about technology and markets, IPR, and

demonstrations both reinforcing existing business and technology areas and highlighting areas that did not exist or weren't tangible

Similarly, the activities have output additionality at three levels. First the funding has *Leverage:* the projects have been completed with more scale and depth and with more quality than would have been possible without the funding. The funding has contributed to creation of *business, products and services:* the projects have contributed to technology development and products and increasingly services based on the technology. The projects have also attracted business and contributed to start-up activity in various business and technology areas. Lastly, the funded RDI creates knowledge

Knowledge: the projects have created knowledge, IPR, and pre-commercial demonstrations. They have also highlighted new areas of business and technology for commercial exploitation.

Finally, the systemic effects of Tekes activities regarding large enterprises and research organisations have contributed to the following systemic effects:

Partnerships: The projects have broadened networks, introduced new partners to each other, and contributed to stable partnerships and networks beyond project duration.

Culture (behavioural additionality): The projects have contributed to renewal of ideas and practices in various organisations. At its most fundamental the projects have raised a new generation of researchers and managers into a new networked operating model.

Dialogue and common vision: The projects have created dialogue between regulators, industry, researchers, and end users to create mutual understanding of challenges and opportunities in given business areas. The projects have also contributed fundamentally to stabilising technology and business areas through joint understanding of the areas of technology and business and associated challenges.

1 BACKGROUND AND OBJECTIVES OF THE STUDY

1.1 BACKGROUND AND RATIONALE

The role and strategy of Tekes, now a part of Business Finland, have evolved with the policy rationale. Tekes activities have shifted from funding collaborative R&D, especially between large enterprises and research organisations, more towards growth-oriented SMEs and start-ups. Meanwhile, innovation policy has increasingly shifted from market failure -thinking towards fixing system failures, which has in turn given a rise to policies focused on ecosystems, here understood (in line with Business Finland's definition) as a *'system consisting of different (public, private and individual) actors organised around a platform and a shared strategic vision in order to produce value for the ecosystem participants and clients'*.

Finland has a long tradition in various innovation oriented Public-Private Partnerships (PPPs), and the recent OECD country review recommended Finland to refocus on R&D and innovation as a source of growth and welfare and to rejuvenate and reconfigure the PPP-approach to innovation. These recommendations serve as a backdrop for this assignment we interpret as a study on Finnish prior PPP-arrangements and the lessons that can be derived for the next generation PPPs and for the recently established Business Finland.

1.2 OBJECTIVES AND QUESTIONS

The wider objective of the assignment is to study what is the role of an innovation in fostering co-operation between actors within the innovation system, and how can the agency contribute to formation of innovation and business ecosystems and enable or foster value creation by and for enterprises, research organisations and society at large. The main questions are:

1. How Business Finland (Tekes) activities for research organisations and large enterprises have succeeded in developing new platforms, and in recent years to ecosystems in the Finnish innovation environment?
2. How research, development and innovation (RDI) funding and services have improved the utilisation of research results in renewed enterprises and fostered competitive advantages of new business areas in the Finnish economy?

3. What is the impact of public RDI funding for research organisations and large enterprises overall in the Finnish economy and society?

1.3 STUDY STRUCTURE, METHODS AND DATA SOURCES

The following pages of the report and particularly the main findings have been structure around the assigned main target groups of the study: Large Enterprises, (Public) Research Organisations (ROs, including higher-education institutions and public/former sectoral research institutes), and the former Strategic Centres of Science, Technology, and Innovation (SHOKs).

FIGURE 1. Structure of the study.

Figure 1 illustrates the structure and process of the study. The general approach to the study is to follow **outcome harvesting** approach as a cross-cutting analysis method to compile evidence from various sources and with various methods to provide evidence of impact. The chosen level of analysis is the project-level and various sources of data are used to analyse the contribution and additionality of funding to (different types of) projects. The main methods employed in the study are the following:

- **Literature study:** Review/survey of literature on development of ecosystems. Also, study of documents related on Tekes/Business Finland strategy and funding.
- **Archival study/statistical analysis:** Analysis of Tekes funding data from projects ending between 2006 and 2017 and R&D statistics.
- **Survey:** A web survey, that was sent to 2700 contact persons of projects that have ended 2006-2017 from the three main focus groups of beneficiaries. Out of those 34 percent of the contact addresses were invalid. In total 390 individual responses to the survey were recorded which means a response frequency close to 22 percent. The total number of individuals responding to the survey were 136 for the mail-group Large Companies, 212 for Public Research Organisations and 42 for participants in the SHOK RDI programmes (as opposed to personnel working in the SHOK enterprises).

The composition of organisations in the group "Large Companies" was 111 private enterprises, 20 others and 5 higher education institutions. The corresponding numbers for the group Public Research Organisation were 145 Higher Education Institutions, 65 research institutes and 2 others. Finally, the numbers for the SHOKS were 9 Higher Education Institutions, 4 research institutes, 4 other and 25 private enterprises. Since the respondents from SHOKs are very heterogenous these responses are analysed separately.

- **Case studies:** Case study including interviews, document and archival analysis related to ten cases of funded projects, four led by large enterprise, three by ROs and three SHOKs.
- **Workshop:** Validation of analysis and development of and recommendations

2 THE CHANGING CONTEXT

2.1 STRUCTURE AND DEVELOPMENT OF RDI IN FINLAND

Finland has generally fared well in international comparisons of the RDI system and policy framework, including the European Commission Research and Innovation Observatory (RIO), World Economic Forum Global Innovation Index and OECD Country Reviews. However, during the last few years development has stagnated and has not matched many other developed countries. As measured by intensity of R&D investment as a fraction of GDP, Finland has been surpassed by European countries, including Sweden, Austria, Denmark and Germany.

Looking at recent trend in R&D investment in Finland, the government expenditure on R&D was 0.22 percent of GDP and business sector expenditure on R&D (BERD) as fraction of GDP 1.81. Both these figures in Finland are roughly EU average and comparable to other small open knowledge economies. However, there are structural differences in that the percentage of government R&D, including universities, research institutions and colleges, is relatively heavily financed by industry, while the other way the portion of business expenditure on R&D is much less financed by the government than the EU average. This latter is explained by the fact that large enterprises typically spend some of their R&D expenditure for funding joint projects. For example, up to 80 percent of Tekes funding for large enterprises have been spent on services from research organisations and SMEs.[1]

The present gross R&D intensity of 2.7 percent of GDP is far from the ambitious goal of 4 percent set in the Research and Innovation Council's vision for 2030, and it has dropped significantly from the high of over 3 percent. In short, Finland is the only country in the EU that invested less in RDI in absolute sums in 2017 than in 2007 and most others (21-member states) have increase RDI intensity while Finland has decreased.

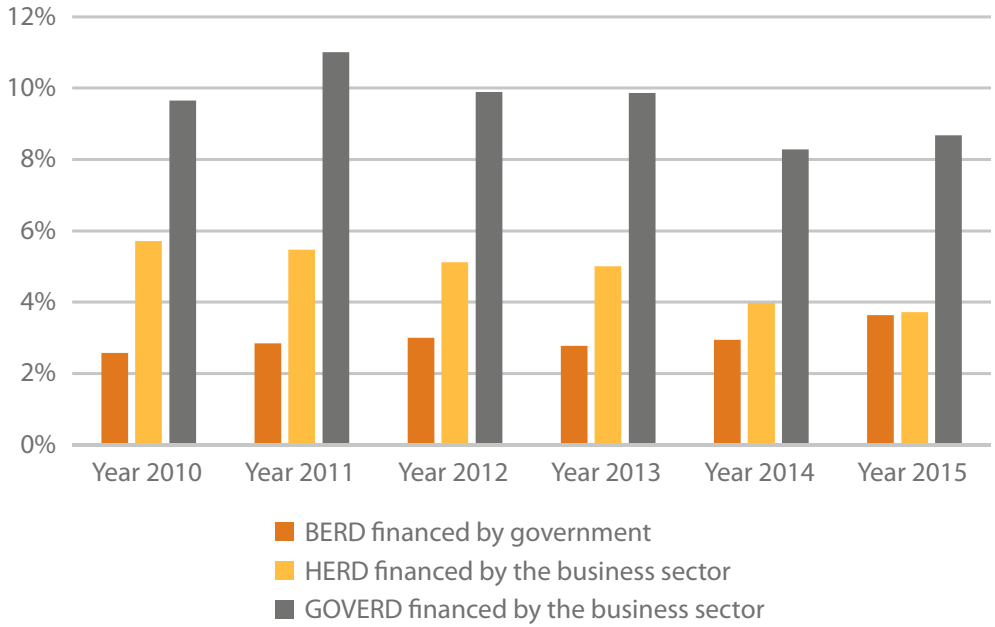
The decline in business spending in R&D was coupled with cutbacks in government funding for R&D. Altogether the commitment of stakeholders to a joint vision of

[1] Statistics Finland, 2017, "Contraction of research and development expenditure slowed down" http://tilastokeskus.fi/til/tkke/2016/tkke_2016_2017-10-26_tie_001_en.html

TABLE 1. Expenditure on R&D in Finland and in selected benchmark countries. Year 2016 or later.[2]

	FIN	SWE	DK	NO	NL	EU
Gross expenditure of R&D (% of GDP)	2.75	3.33	3.06	2.03	1.99	2.07
Business sector R&D (% of GDP)	1.81	2.26	1.89	1.08	1.16	1.24
Higher education R&D (% of GDP)	0.69	0.87	0.91	0.66	0.64	0.44
Government intramural R&D (% of GDP)	0.22	0.11	0.06	0.29	0.23	0.23
Share of GOVERD financed by the Business (%)	8.67	3.95	1.22	7.38	13.59	7.85
Share of BERD financed by the Government (%)	3.64	6.13	2.82	9.35	1.86	6.35
Share of HERD financed by the Business (%)	3.72	4.02	2.61	3.13	7.85	6.44

FIGURE 2. Share of sectoral cross-financing of R&D in Finland 2010–2015.[3]



a knowledge-based society with investments at the forefront of innovation is not evident anymore in the same way it was during the last financial crisis in the beginning of 1990s.

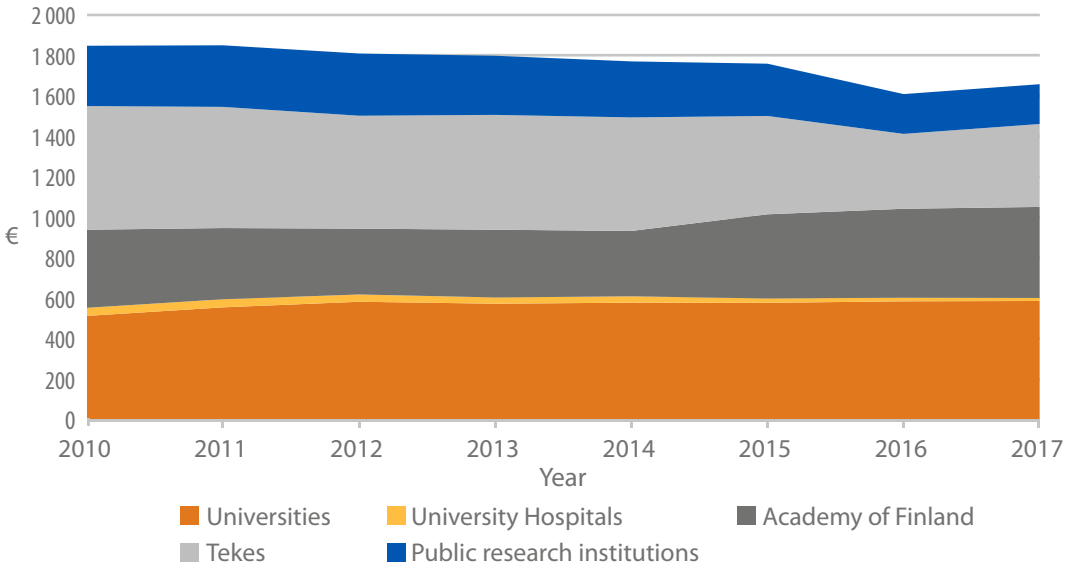
Private and public sector cuts in R&D expenditure have had an impact on their mutual collaboration. Figure 2 shows the overall lowering trend of cross-sectoral R&D financing in 2010–2017. The business sector has typically financed around 10 percent of government R&D expenditure, which has declined to a level around 8 percent. Similar trend is visible on business financing of higher education R&D, which has dropped below 4 percent. On the other side, government financing of business R&D has more or less remained at the 3 percent level, with the exception of 2015.

[2] OECD/Eurostat
[3] OECD

Hence, the relative share of business sector financing of higher education R&D is twice as high, and financing of government R&D is three times higher, than the share of government financing of business sector R&D. Of course, the volume of business sector R&D is twice as high as the government and higher education sectors together.

Two of the main contributors to cutback in RDI investment are the austerity measures implemented due to the poor recovery and economic stagnation following the financial crisis of 2008 and the downscaling of Nokia RDI following the implosion of the mobile handset business. Finland experienced a sharp shock in the financial crisis of 2008–2009, particularly due to the drop of ICT exports that is intertwined with Nokia's restructuring. Recovery in terms of GDP, jobs and productivity has been relatively slow, as the crisis revealed an underlying need for economic restructuring besides recovery from the financial crisis. These coinciding factors have meant both cuts to public RDI subsidies and contraction of private investment at the same time. The public budget cut has particularly been directed to Tekes, basic research funding has been quite stable, and the main austerity measure has been freezing index correction to budgets. These effects are particularly noticeable in the collaboration between ROs and enterprises, and consequently the RDI funding from enterprises to universities has decrease approximately 40 percent between 2010–2017.

FIGURE 3. Development of government funding for R&D by organisation 2010–2017 (euro, million).[4]



[4] Statistics Finland

In 2018, despite the unfavourable development in RDI investments, private sector invested 2/3 of total RDI and as a whole government spending has not been cut as much as redistributed. Spending on basic research, including appropriations for universities, has increased 10 percent between 2011 and 2018, whereas investments in technology and industrial development has been decreased by approximately 30 percent and health and wellbeing by 60 percent. Two major actions responsible for these numbers are budget cuts for Tekes and to the National Institute for Health and Welfare.

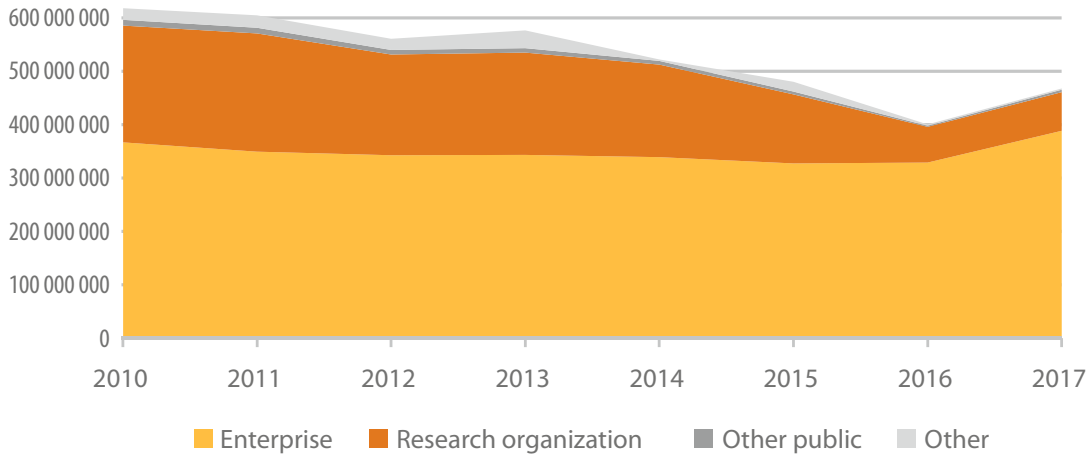
The historical focus on Finnish innovation policy has been building collaboration between industry and research. Tekes programmes have represented a good

example of this tradition, in which funding has been granted for consortia made of research organisations and industry, often medium or large incumbents and in recent times also increasingly for SMEs.

Especially since the current government started in 2015, RDI policy has been reconfigured relatively heavily, which has influenced Tekes funding and funding allocation. While the budget for academic (basic) research has remained relatively stable over the last years, the last two governments have lowered the budget appropriations for applied research and innovation funding, including funding channelled through Business Finland.

Recently however, there has been a change in R&D budget appropriations between different types of public RDI funding. In practice, the amount of total funding granted by Tekes / Business Finland dropped from the level of 618–561 million euro per year in 2010–2014 to the low of 417 million euro in 2016 (see more Table 2). Year 2010 marked an all-time high in Tekes budget appropriations with the 618 million euro. In 2017 the appropriations climbed back up to more than 500 million euro.

FIGURE 4. Development of Tekes funding over the years by type of beneficiary.[5]



In general terms, the traditional aimed funding split between client segments has been for 2013–2016 and 2015–2018 "one third for research organisations, two thirds for enterprises" and from the latter one third for young (under 6 years) SMEs, another third for (other) SMEs, and the last third for large enterprises.[6] In practice the granted funding has hovered around roughly 40 percent for enterprise subsidies, another 40 percent for research organisations and the rest in loans with a slight increase in the portion of loans instead of subsidies, up until the last strategy period where a shift in the fractions can be observed. In 2015–2017 altogether 77 percent of Tekes funding was granted for enterprises.

Tekes funding instruments have been geared towards SMEs and start-ups, and accordingly the share of large enterprises out of total funding for enterprises has lowered from 36 percent (2010–2014) to 24 percent (2015–2017). The portion of funding granted as loans has increased from the average of 22 percent of total funding between 2010–14 to 35 percent in 2015–2017. Simultaneously the funding for research organisations has dropped from 35 percent to 20 percent out of Business Finland grants, or more than 50 percent in absolute

5 Business Finland open data

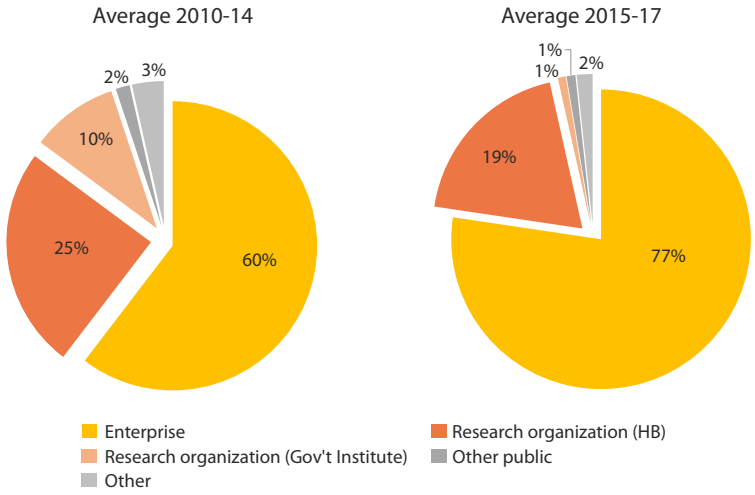
6 Tekes, 2010. Toiminta- ja taloussuunnitelma 2013-2016; Tekes 2013. Toiminta- ja taloussuunnitelma 2015-2018

sum, from the previous level. The absolute sum of funding for public research institutes specifically in 2017 was 1/20th of the 2010 level. In practice research organisations, and particularly public research institutes, share of funding has absorbed much of the decrease of the overall budget.[7] These changes are a function of shifting policy goals and changes in instrument or programme structures to favour SMEs and start-ups.

During 2017 Tekes funding for universities and research organisations remained at the same 102-million-euro level as in the previous year. In order to compensate for the drop in 2016 in networking of companies and research organisations, the focus of research funding was shifted more towards well-networked joint projects.[8] As a result of the mid-term review of the Programme of the current Government, Tekes was given additional (equity) allocations for 2018–2019 to be used for boosting ecosystems and so-called Growth Engines.[9]

Within the overall consignment of funds, the tasks of Business Finland have been broadened from the traditional mission of RDI funding towards administering other subsidy programmes, such as an Audio-visual production subsidy programme on behalf of the Ministry of Transport and Communication, and also venture capital fund. Thus, the role of substance driven RDI programmes is getting smaller.

FIGURE 5. Yearly split of funding between types of beneficiary, overages of years 2010–14 and 2015–17.[10]



Altogether, the bias in public R&D funding has shifted towards scientific or basic research on the one hand, and on the other, as the public funding for business R&D and applied research has declined overall and has shifted towards refundable instruments, ***it has been steered closer to markets***. Therefore, funding for applied research, including strategic technology development, radical innovations and future competence building has weakened.[11]

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7 Business Finland Open data, retrieved 10.10.2018
8 Annual Report (Tilinpäätös) 2017, Tekes
9 Finland, a land of solutions. Mid-term review and Government Action Plan 2017–2019. Government Publications 7/2017.
10 Business Finland open data
11 Statistics Finland 2017 Government R&D funding decreases further in the budget for 2017
http://tilastokeskus.fi/til/tkker/2017/tkker_2017_2017-02-23_tie_001_en.html

2.2 RECENT CHANGES IN RDI STRUCTURE AND FUNDING

While changes in funding are easily visible from statistics, recent years have seen also large changes in the structure of the RDI system. One fundamental change has been University and Higher Education reform (2009 the present University law came into effect) that changed the funding model and mission of universities and colleges. In the new funding model universities are more independent, but also depend more on external funding.

In line with other research organisations, public sectoral research institutes have also been reformed. The need for reform was raised in the OECD country review of 2010, where the concept of sectoral research was deemed somewhat outdated as societal problems often span multiple sectors, while the review maintained that there is generally more need to for evidence-based decision and policy making, monitoring and evaluation. Structural reforms meant that some institutions were merged with one another or into universities. Overall, the ROs were given more autonomy, while basic funding was cut with the promise that grant funding will increase. A major initiative in this respect was founding of the Council for Strategic Research within Academy of Finland in 2014, which funds policy relevant research. Similarly, the Prime Minister's Council started a new funding instrument, called Government Analysis, Assessment and Research Activities, that doles out grants for policy-relevant studies and evaluations.

The effect of research institute reform to funding was a relatively small fraction in the larger development of funding, but for some individual institutes it was drastic. For example, the National Institute of Health and Welfare saw a budget cut of more than 50 percent. VTT budget was cut 20 percent but in absolute sum that represents the third of the total sum. What this meant in practice, was that ***the budget reductions weakened the institutes and incentivised the use of external funding, and consequently made building the competence needed for collaborative RDI more difficult***.

The latest OECD Country Review of Finish innovation system was published 2017.[12] The evaluation highlighted the culture of collaborative RDI as one of the long-time strengths of the Finnish system. On the other side, major weaknesses included fragmentation of the system and lack of strategic investment. The evaluation called for more integrated approach, and joint planning and programming between the policy agencies. But also, as discussed above, ***the changes in funding distribution poses a challenge as the established sources for collaborative RDI Finland has been known for, have been hit the hardest by the recent developments***.

[12] Suomen innovaatiopolitiikan OECD-arviointi 2017.Kokonaisarviointi ja suositukset (epävirallinen suomennos). Työ- ja elinkeinoministeriön julkaisuja 25/2017.

2.3 LARGE ENTERPRISES, RESEARCH ORGANISATIONS AND THE SHOKS – THE BIG THREE

LARGE ENTERPRISES

In Finland, 55 percent of enterprises (with more than 10 employees) reported innovation activity in 2012–2014, which is above the EU average.[13] However, R&D in enterprises in Finland is dominated by large enterprises (73 percent of R&D). While Tekes targets funds for supporting R&D in large enterprises, at the same time up to 80 percent of funding granted to large enterprises is channelled back to research organisations and SMEs, as also witnessed by the relatively large share of business spending in GOVERD.

Tekes has not systematically published the details of their funding distribution of funding paid out to enterprises, but for example in the beginning of 2010s, the split between different types or size of enterprise was roughly equal thirds between young 'growth-seeking' SMEs, established SMEs, and large enterprises including "mid-caps"[14]. In 2016 ca. 90 percent of Tekes funding for enterprises was targeted to enterprises less than 250 employees, i.e. SMEs. In 2007 the funding for start-ups (enterprises less than 6 years old) was around 50 million euros, and in 2016 142 million euros. These figures clearly show the shift towards small enterprises and start-ups.

The main funding instruments for large enterprises have been thematic programme funding, non-programmed funding for 'challenging and renewing projects', and increasingly R&D loans and guarantees, and SHOK-funding, which is discussed in more length below.

While Finland has traditionally ranked very high in the intensity and frequency of business-academia cooperation, the total volume of privately funded research performed by research organisations is relatively low, and most of the private R&D investments are focused on improvement of existing products. Therefore, ***private R&D investments are not reaching for radical new-to-markets innovations which may indicate weak incentives – both demand-driven and funding incentives***.[15] The dwindling of this connection is also evident in the downward trend in research funding from enterprises to public research organisations.

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13 Statistics Finland 2016 Over one-half of innovators reported innovations with environmental benefits, http://tilastokeskus.fi/til/inn/2014/inn_2014_2016-06-02_tie_001_en.html; Statistics Finland 2017 Government R&D funding decreases further in the budget for 2017 http://tilastokeskus.fi/til/tkker/2017/tkker_2017_2017-02-23_tie_001_en.html

14 A Mid-Cap is a 'small large enterprise' with somewhat loose definition, but generally understood to be over 250 but less than approx. 3000 employees, in Finland more specifically 250-500 employees and less than 300MEUR turnover

15 Halme, K; Saarnivaara, V-P, and Mitchell, J, RIO Country Report 2017: Finland, euro 29149 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-81196-8, doi:10.2760/415082, JRC111280.

RESEARCH ORGANISATIONS

Finland houses a variety of public research organisations (heretofore ROs), including universities (14), public research organisations (12) and universities of applied sciences (23+2). Public research organisations, such as sectoral research organisations, of whom Technical Research Centre of Finland VTT is among the most active, perform about 9 percent of all R&D activities. Over all GERD by public research organisations was 0.25 percent of GDP in 2016, while the EU28 average was 0.24 (in 2015). As discussed, recent reforms have significantly changed the funding and structure of the country's public research institutes over the past decade. Amidst the reforms, the budgets appropriations for sectoral research organisations have been on a steady decline and share of funding for research from outside sources was 55 percent in 2016.[16]

Higher education institutions' (HEIs') renewed funding resembles the other research organisations, as budget funding has declined or been frozen and HEIs have been directed towards external grant funding. The exception is that the basic funding from the Ministry of Education emphasises scientific quality and impact. HEIs perform around 25 percent of all R&D activities in Finland. Universities' share of the HEI R&D expenditures was 86 percent, universities of applied sciences' share 9.6 percent and university hospitals' share 4.5 percent. GERD as a percent of GDP performed by HEIs was 0.69 percent in 2016 (EU28 average 0.47 in 2015).[17]

While the overall Government R&D funding decreased in the state budget in 2017 by 2.5 percent from the year before, based on the Government decisions in 2016 and 2017, the cuts in Tekes' awarding mandate in 2015–2017 (21 percent decrease) will be realised as paid funding after a couple of years. The cuts in Tekes budget from 2015 to 2016, caused also decline in funding targeted for universities and public research organisations.

STRATEGIC CENTRES FOR SCIENCE, TECHNOLOGY AND INNOVATION (SHOKS)

Industry-led cluster policy began in Finland in the early 1990's in parallel to many other European countries. First national cluster programmes started with the then Science and Technology Policy Council's (STPC, later Research and Innovation Council, RIC) additional R&D funding in 1996, and lasted until early 2000s. These cluster programmes Forest, Health and well-being, Foodstuff, Logistics, ICT and the Environment were initially led by their respective ministries. The cluster programmes were then followed in 2006/2007, again on

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16 Statistics Finland 2016 Research and Development http://www.stat.fi/til/tkke/2016/tkke_2016_2017-10-26_kat_001_en.html; Halme, K; Saarnivaara, V-P, and Mitchell, J, RIO Country Report 2017: Finland, euro 29149 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-81196-8, doi:10.2760/415082, JRC111280.

17 Statistics Finland 2016 Research and Development http://www.stat.fi/til/tkke/2016/tkke_2016_2017-10-26_kat_001_en.html; Halme, K; Saarnivaara, V-P, and Mitchell, J, RIO Country Report 2017: Finland, euro 29149 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-81196-8, doi:10.2760/415082, JRC111280.

the recommendation of the STPC, by six Strategic Centres of Science, Technology and Innovation (SHOKs), that followed roughly the same industry borders, with the exception that logistics was supplanted by construction industry.[18]

The aim of the programme was to help accelerate the process of innovation and renewal of Finland's industrial clusters by creating new competences and inducing radical innovations at the system level. In this context SHOK operations sought to apply new methods of cooperation, co-creation and interaction. International cooperation was also intended to play an important role here. Furthermore, the testing and piloting of creative research environments and ecosystems was an additional element of SHOK operations. The SHOKs were intended as a public-private -partnership (PPP) type of organisation. The SHOK organisations, partnering enterprises and research organisations were intended to carry out research based on a joint agenda with a view 5-10 years into the future and in close collaboration.

The SHOK concept was evaluated in 2013. By that time, SHOKs had become one of the principal instruments of Finnish innovation policy. There were six SHOKs operating in Finland; Cleen, FIMECC, SalWe, TIVIT (later DIGILE), RYM and Forestcluster (later Finnish Bioeconomy Cluster, FIBIC). SHOK programmes were financed with a total over 343 million euro between 2008 and September 2012. On average, 60 percent of funding came from Tekes and 40 percent from enterprises involved in the SHOK programmes. At its largest, Tekes committed up to approximately a quarter of their yearly funding through the appropriation dedicated for the SHOK programmes.

It is also worth mentioning that in parallel to national cluster programmes and SHOKs, there has been a number of other significant (inter-) regional (e.g. OSKE, INKA) and cross-national (e.g. Eureka, EU/JTI, ERDF, etc.) innovation programmes and with ties to Tekes programmes and activities.

2.4 PREVIOUS STUDIES EMPHASISE RADICAL INNOVATIONS

A national reform of public research organisations was approved by the Government in 2013 and was conducted between 2014-2017, with the aim to improve the coordination, efficiency and effectiveness of the public research as part of the larger research and innovation ecosystem. The reform has initiated major reorganisations and the merging of research institutions and reallocation of their funding, among others.[19]

According to 2012 evaluation of Tekes, there is clear evidence the impact of Tekes activities, which suggest that enterprises with Tekes funded R&D investments invest more of their own money to R&D than those enter-

[18] For this section, see Lähteenmäki-Smith et al 2013 License to SHOK: Evaluation of Strategic Centers of Excellence, Ministry of Employment and Economy

[19] Valtioneuvoston periaatepäätös valtion tutkimuslaitosten ja tutkimusrahoituksen kokonaisuudistukseksi, 5.9.2013.

prises that are not targeted by Tekes funding. According to Van der Vaal et al., ***"Tekes funding has increased the quality and quantity of firms' innovation activities, increasing firms' knowledge capital as well as extent of spill overs."*** The evaluation sees SHOKs somewhat problematic, due to a lack of common vision and short time horizons. Furthermore, according to the evaluation, SHOKs are crowding out challengers and possibly having too open IPR regulations for enterprises to contribute their ideas. Regardless of the challenges that SHOKs are facing, the evaluation views SHOKs as a right way to go.[20]

Tekes' role was again addressed as part of the OECD Review of Finnish Innovation Policy in 2017. According to the review, Tekes programmes have played a significant role in the Finnish industrial development since early 1980s. The programmes have been addressing both competitiveness and productivity by aiming to improve productivity in existing industries and by supporting new, high-productivity enterprises and industries. Typically, 90 percent of the subsidy of Tekes was passed on to SMEs and public research organisations. Tekes has also allocated funding to large enterprises on the basis that the enterprises would use subsidies on research, development, and innovation, or pass the subsidy upstream to SMEs generating spill overs. According to the OECD report, the key change in Tekes' role was introduced in 2008. Tekes extended its activities to supporting SMEs and start-ups. Although it is estimated that funding for enterprises less than six years old more than doubled between years 2006–2015, the report mentions that SMEs' share in business R&D and export is small overall. Hence, ***OECD suggests that public support for business innovation should be strengthened and priority given for projects that are developing more radical innovations***.[21]

Initially the SHOK model was considered a welcome promoter of industry-driven research in Finland and the centres successfully defined their own research agendas. However, the evaluation of SHOK concept in 2013 highlighted significant challenges with their operating models, and with the results and effectiveness of the centres. These ***included the multiple, and often internally contradictory, objectives of the SHOKs and the unclear governance model***. Tensions were identified between the short-term interests of industry and the longer-term perspective required in the promotion of cutting edge or 'breakthrough' scientific research. Despite the high expectations, the internal dimensions of SHOK activity had remained low when it comes to achieving internationalisation and a cross-scientific, multi-disciplinary presence.

Partly on the basis of the evaluation results, the SHOK programme was phased out between 2015 and 2017 as an austerity measure. The SHOKs were already singled out as a target for funding cuts during the negotiations leading up to the formation of the government after the

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20 van der Veen et al. 2012. Evaluation Tekes, Ministry of Employment and Economy, Publications 22/2012

21 OECD Reviews of Innovation Policy: Finland 2017

2015 elections, but the last nail in the coffin was the overall cut in Tekes's budget that left the SHOKs entirely exposed. In practice new SHOK programmes were not granted funding after the formation of the Government programme in spring 2015 and the existing SHOK programmes were funded based on previous agreements with the funding tapering off during 2017.

Number of quantitative impact assessments of Tekes funding has been conducted over the years, with slightly different models, but with repeatable and robust results: ***Tekes funding has on average had a neutral-positive effect on the growth, productivity, employment and exports of companies in the long term***.[22] The most recent impact assessment currently being conducted for the European Commission appears to support these findings, and estimates that receiving a grant from Tekes has had a positive impact on job creation and R&D intensity among beneficiaries.[23] For comparison, the impact of Tekes subsidies is rather similar to that of the Research and Innovation Actions of Horizon 2020[24].

In terms of spill-over effects, it has been estimated in an older study from 2013 that funding beneficiaries internalise only approximately 60 percent of the benefits, indicating a significant spill-over to partners and society through knowledge and technology transfer.[25]

The studies also point out that the effects are, however, highly heterogeneous and, as is common in other risk-taking endeavours, their returns vary greatly between beneficiaries. Additionally, there are methodological challenges that make isolating the net impact of public funding near impossible, chief among them the mentioned externalities and the fact that a large portion of comparable enterprises at a given time are either beneficiaries or recently have been.

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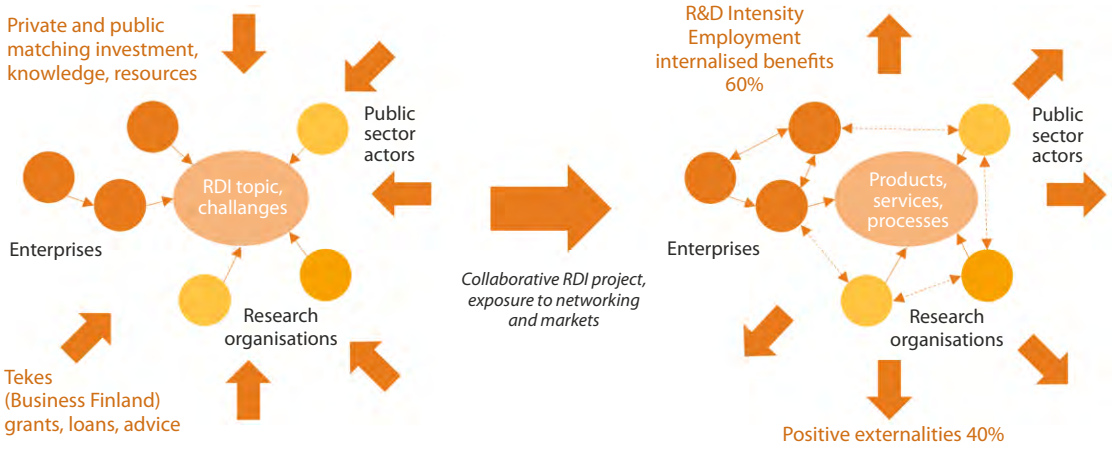
22 E.g. Ylhäinen, Rouvinen, Kuusi, 2016, Katsaus yksityisen t&k-toiminnan ja sen julkisen rahoituksen vaikuttavuuteen, Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 57/2016; Halme, Kimmo, Annu Kotiranta, Mika Pajarinen, Kalle A. Piirainen Petri Rouvinen, Vesa Salminen, and Ilkka Ylhäinen. 2018. Efforts of Finnvera, Finpro, and Tekes in Promoting Internationally Oriented SMEs – Impact Study, Business Finland, Helsinki, FI; Viljamaa, K., Piirainen, K., Kotiranta, A., Karhunen, H., Huovari J., 2014. Impact of Tekes Activities on Productivity and Renewal, Tekes Reviews 315/2014, Finnish Funding Agency for Technology and Innovation – Tekes, Helsinki, FI

23 Fornaro et al. 2018, Evaluation of Tekes R&D Funding for the European Commission – The Interim Report, Report 8/2018, Business Finland, Helsinki, FI

24 Piirainen, Kalle A. (editor), Kimmo Halme, Tomas Åström, Neil Brown, Martin Wain, Kalle Nielsen, Xavier Potau, Helka Lamminkoski, Vesa Salminen, Janne Huovari, Anti Kekäläinen, Henri Lahtinen, Hanna Koskela, Erik Arnold, Patries Boekholt, Helene Urth, 2018. How can the EU Framework Programme for Research and Innovation increase the economic and societal impact of RDI funding in Finland? Publications of the Government's analysis, assessment and research activities 8/2018, Prime Minister's Office, Helsinki FI

25 Takalo, T., Tanayama, T., Toivanen, O. Estimating the Benefits of Targeted R&D Subsidies, The Review of Economics and Statistics, March 2013, 95(1): 255–272

FIGURE 6. Summary of findings from impact assessments.[26]



2.5 STRATEGY SHIFT TOWARDS GROWTH ACCELERATION

During the strategy period 2011–2014 significant Tekes activity was focused funding specific R&D projects, commonly in consortia between enterprises and research organisations through the RDI funding programmes. Differing from today, in 2011 Tekes set an objective to grant up to 30 percent of the budget to research organisations, including universities and sectoral research institutions. In 2011 significant portion was still granted for large enterprises for renewal, but already then Tekes had started moved significantly towards SMEs and start-ups.

The rise of entrepreneurship and specifically growth-oriented small enterprises on the policy agenda started to show during the 2011–2014 strategy period, and Tekes stated that internationally oriented growth-seeking enterprises, particularly SMEs, were the most important client group for Tekes. For example, the Young Innovative Companies (NIY) instrument was launched in 2008 with the aim to offer business development support for young enterprises with high growth ambitions and international market potential. ***Since 2015, Tekes activities have shifted from funding collaborative R&D more heavily towards funding growth-seeking SMEs, entrepreneurship and start-ups.*** One particular driver has been the focus in the current Government towards supporting entrepreneurship and SMEs as a device for growth and renewal of the economy.

Also, the nature of the Tekes programmes has changed in the 2010s. In the previous strategy period, the programmes were more built alongside existing industry and value chain boundaries, but in the period towards 2017, programme focus has moved increasingly to horizontal or cross-cutting topics, such as digitalisation, circular economy etc. Additionally, ***the focus on ecosystems has strengthened and Tekes is experimenting with fostering ecosystem within the bounds of existing instruments***. After SHOKs Tekes have funded for example the Hilla concept and other smaller scale ecosystems to experiment with how different instruments can support formation and growth of ecosystems.

[26] Ibid.

In March 2017, the Government announced that Tekes and Finpro – the Finnish trade promotion organisation – would unite as a new agency called Business Finland. The Ministry of Economic Affairs and Employment started its preparations for establishing the operator immediately, and Business Finland started operating at the beginning of 2018. The aim of the reform was to create an agency, which could take into account the entire life cycle of regeneration, growth, and internalisation of enterprises. Therefore, the operator would help the government to achieve its goal to double exports of SMEs by 2020. The merger of Tekes and Finpro was also done to reduce overlapping of the public services.

The mission of Business Finland is to promote the development of industries and services through technology, innovations and growth funding. This would renew occupations, increase the value-added, increase the productivity of the economy and create more exports, jobs, and prosperity. The values of Business Finland are inspiring enterprises to renew their business operations and to seek for growth, making decisions that have an impact for the future of the Finnish economy, and doing sustainable and reliable policy.

The goal of the Business Finland is to be an accelerator of global growth. Objectives of the *Business Finland 2018 strategy* are to create possibilities for enterprises to grow their share in the global markets, to help customers to reinvent their business operations, support growing ecosystems and build a world-class innovation environment in collaboration with partners in Finland. The most important target group is enterprises seeking growth and internalisation. Another important target group is research and development that can be used as a tool for growing and improving business.

As discussed, there are changes that have shortened RDI programme and project cycle. This marks a reversal of the development between roughly 2006-2015 when the trend was towards larger consortia and longer projects with relatively ambitious, broad and transformative goals, particularly in the SHOKs and strategic research openings. The recent years have brought back an emphasis to projects similar to "traditional Tekes projects" of short 1-2-year efforts with a relatively narrow focus on solving specific problems with smaller consortia.

Any one of these changes might not be significant in isolation but taken together they mark a ***major shift in the focus of RDI policy from building a consistent continuum of strategic investment from basic research, pre-commercial applied research, industrial R&D and competence development, and finally innovation, towards short-term innovation and commercialisation/ growth activities***. In other words, the changes in policies are risking creating a gap between academic research activities and knowledge generation, and exploitation of that knowledge, whether that is intended or not.

TABLE 2. Evolution of Tekes/Business Finland Strategy.[27]

Tekes/Business Finland strategy	2011–2014	2015–2017	2018–
Goals	Welfare through renewal of industry and growth	Globally competitive business and industry, top-level innovation environments, innovation-led export growth	Globally competitive business and industry, top-level innovation environments, innovation-led export growth
Target groups	Growth-seeking exporting SMEs, high-risk growth-oriented projects, renewal of large enterprises when significant positive externalities	"Businesses seeking renewable growth in the international market", growth-seeking export-enterprises, particularly SMEs and start-ups	Growth-seeking SMEs and ecosystems that interface with global markets
Rationale	Growth and renewal through intangible investments and building networks.	Tekes is an active facilitator that enables growth and supports emerging ecosystems.	Business Finland actively creates top innovation environment to offer opportunities for growth-oriented SMEs and world-class platforms and ecosystems.
Focus of funding	• 1/3 for R&D projects by public research organisations and universities • 2/3 targeted for RDI projects of enterprises, of which • 1/3 for SMEs (less than 250 employees) • 1/3 for enterprises with less than 500 employees, "mid-caps" • 1/3 for enterprises with more than 500 employees	• 1/3 for research in universities and public research organisations • 2/3 for R&D&I projects for enterprises	• 1/3 for research in universities and public research organisations • 2/3 for R&D&I projects for enterprises
Main instruments/ services	• Loans • Subsidies • Funding targeted through customer initiatives based on demand • Funding targeted for research projects of the SHOKs • Funding for focus areas of the strategy through Tekes programmes • Funding for the strategic choices/ openings	• Loans • Subsidies • SHOKs • Funding targeted for research projects of public organisations • Funding targeted through customer initiatives based on demand • Funding targeted to the priority axes of strategy • Funding targeted for research projects of the SHOKs	• Loans • Subsidies • Funding generally targeted to the priorities of Business Finland strategy, particularly digitalisation, Bio- and circular economy, Health & Wellbeing • Investments to venture capital funds

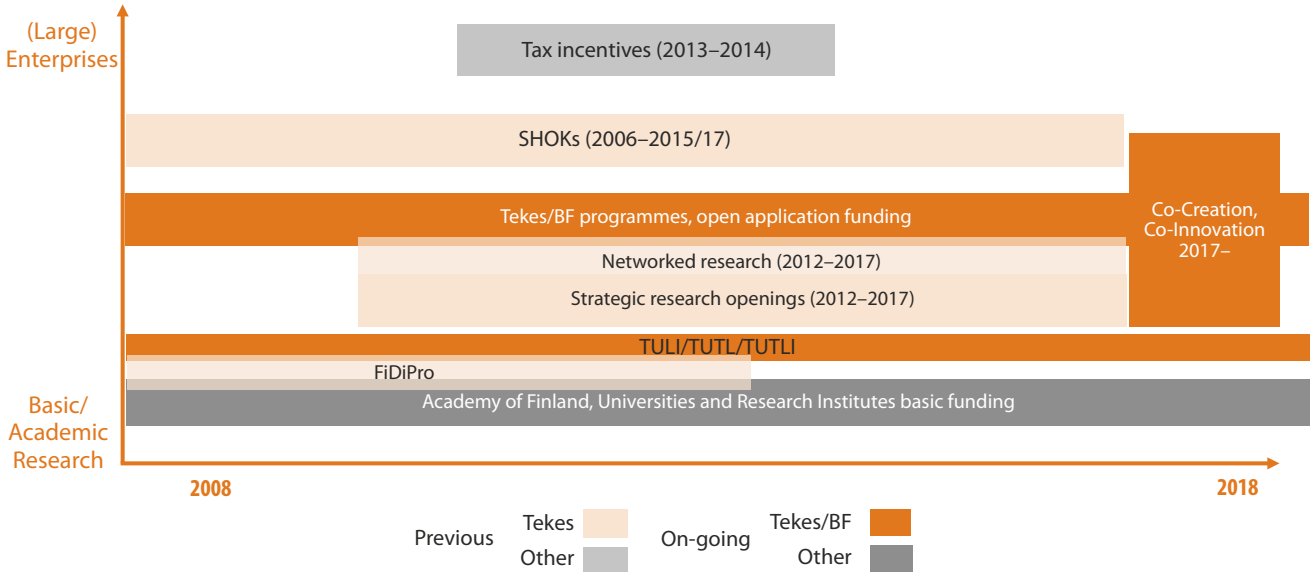
[27] Tekes documentation

2.6 TEKES/BUSINESS FINLAND FUNDING SERVICES FOR THE BIG THREE

Technically Tekes/Business Finland has a limited number of funding *instruments*, and particularly for these groups the main ones are RDI subsidy and RDI loan. These instruments are used within *funding services* such as those described below. Besides subsidies and loans, there are specialised instruments especially for SMEs, including the Young Innovative Companies -instrument, general budgetary support grant and a variety of *De minimis*[28] subsidies, e.g. internationalisation grants (also available for smaller large enterprises, 'mid-caps'). In the following and the rest of this report, 'instrument' and 'funding service' are used interchangeably.

Under the two main instruments, Tekes and Business Finland have implemented various programmes and funding services over time. Figure 7 below condenses the main instruments offered for large enterprises and research organisations, including SHOKs. It is to

FIGURE 7. Timeline of Tekes/Business Finland instruments relevant for the three client groups positioned on the continuum between fundamental/basic/academic research to industrial development (y-axis).



[28] *De minimis* grant in European law means a grant or subsidy so small as not to interfere with the functioning of the markets as per the Treaty of the Functioning of the EU, in practice *de minimis* subsidies cannot exceed 200 000 euro over a two-year period to a given beneficiary.

be noted that the various area or theme specific Tekes programmes fall in the middle under one heading. As illustrated by the Figures 7 and 8, Tekes and now Business Finland have had a pivotal position as a funder in the chain from research through applied research to innovation.

The longest standing instrument or funding service and the main vehicle for funding (large) enterprises has been (Technology) **programmes** and open funding application. The programmes started as Tekes Technology Programmes soon after Tekes itself was founded and continue as Business Finland Programmes. The programmes specify a technology are or other common theme and provide different services for the funded group of enterprises designed to support project implementation and peer learning within the group. In addition, Tekes and Business Finland have always granted RDI subsidies and loans, especially for enterprises, on application without a relation to a predetermined programme. Approximately between 30–40 percent of total Tekes funding in a year has been granted based on open application without specific relation to a programme. These are projects that are initiated by enterprises and they have often at least one partner. Research organisations are welcome and encouraged as partners. In practice it is a requirement that large enterprises spend at least 20 percent of the budget for sourcing from public research organisations and/or SMEs.

Relatedly, there are three types of administrative arrangements for related or joint projects where each partner has a separate but related project: Joint Projects were related but administratively separate RDI projects and Group Projects were related or thematically grouped (individual) RDI projects with one administrative coordinator, and lastly Parallel Projects were RDI projects that parallel another, in practice typically an enterprise can form a parallel project to a public research project to develop commercial applications out of the research findings.

The instruments targeted for applied research have developed over time. Before specific instruments/services, Tekes offered strategic (or applied) **research grants** both under the programmes and as open applications. The long-standing triad of services specifically for ROs was introduced 2012 including **Strategic Research Openings** (hereafter **SROs**) and 'Public research [that is] networked with enterprises' (hereafter **Networked Research or EVET**). SROs and EVET were directed for public research organisations, in practice universities, colleges and research institutes, but EVET required that enterprises participate in funding (up to 10 percent share) of the project and participate as potential users of the results. The SROs were either small openings of maximum 350 thousand euro over two years, or large openings of 5–10 year and up to roughly 10 million euro, applied research projects conducted mostly by research institutions that were focused on developing new technologies, services and business models that would have significant economic impacts. The networked research grants in turn were similar to technology programmes, and by default parallel or related to the programme themes, in that they were shorter applied projects with at least two

enterprises who would also fund at least 10 percent of the total project volume. The calls for applications for SROs and EVET were originally tied to the programme themes of the time, but EVET calls were changed in 2015 to broader thematic calls.

The third component in the public research funding portfolio was and is the New Business from Research Ideas (TUTLI, previously From Research to Business, TULI) funding that offers smaller *de minimis* grants for researchers planning commercialising their inventions and the eligible uses were pre-commercialisation activities such as IPR and market studies. Lastly the remaining instrument is Finland Distinguished Professor Programme (FiDiPro) that was a joint instrument with Academy of Finland for inviting distinguished foreign academics for research stays in Finland.

After Tekes was restructured into Business Finland, the public research funding mandate was carried over to the **Co-Creation** and **Co-Innovation** pair of instruments. Co-Creation is aimed as a demonstration and pre-study for research organisations aiming to prepare for a Co-Innovation project. Co-Creation is similar to strategic openings in its goals, with a stated goal to engage in scientifically ambitious research with enterprise partners based on a jointly developed idea, but it has a maximum duration of 4–6 months instead of years and a budget of maximum 100 thousand euro. The aims of Co-Innovation are to develop new solutions and to develop them towards the markets, with a consortium of at least three enterprises and a number of research organisations and teams. The maximum duration is 2 years.[29] Co-Innovation projects are administratively Joint Actions where at least one research organisation and three enterprises participate, at least two of whom have applied for Business Finland Funding. The administrative arrangement is similar to the previous Group Projects. The new programmes stress equal footing between researchers and industry and common interest, which marks a difference in tone compared to the earlier.

Finally, the **Strategic Centres for Science, Technology and Innovation** (lit. translated Strategic Centres of Excellence, **SHOKs**) programme was a standalone programme loosely coordinated by the Ministry of Economic Affairs and Employment, RIC, and a SHOK Steering Group, where the SHOKs were self-governing non-profit enterprises who managed their RDI programmes. Tekes' role was to fund the SHOK programmes from a specific budget appropriation. The purpose was to bridge the gap between ambitious basic research and innovation by bringing academics and industrialists round the same table and to create lasting networks by setting up these self-governing programme offices who drafted their own Strategic Research Agendas (SRAs) and managed funding together with Tekes. In practice the SHOK organisations lead drafting of one or several SRAs and built consortia for one or several RDI programmes under each SRA. These programmes were generally submitted to Tekes for review and funding.

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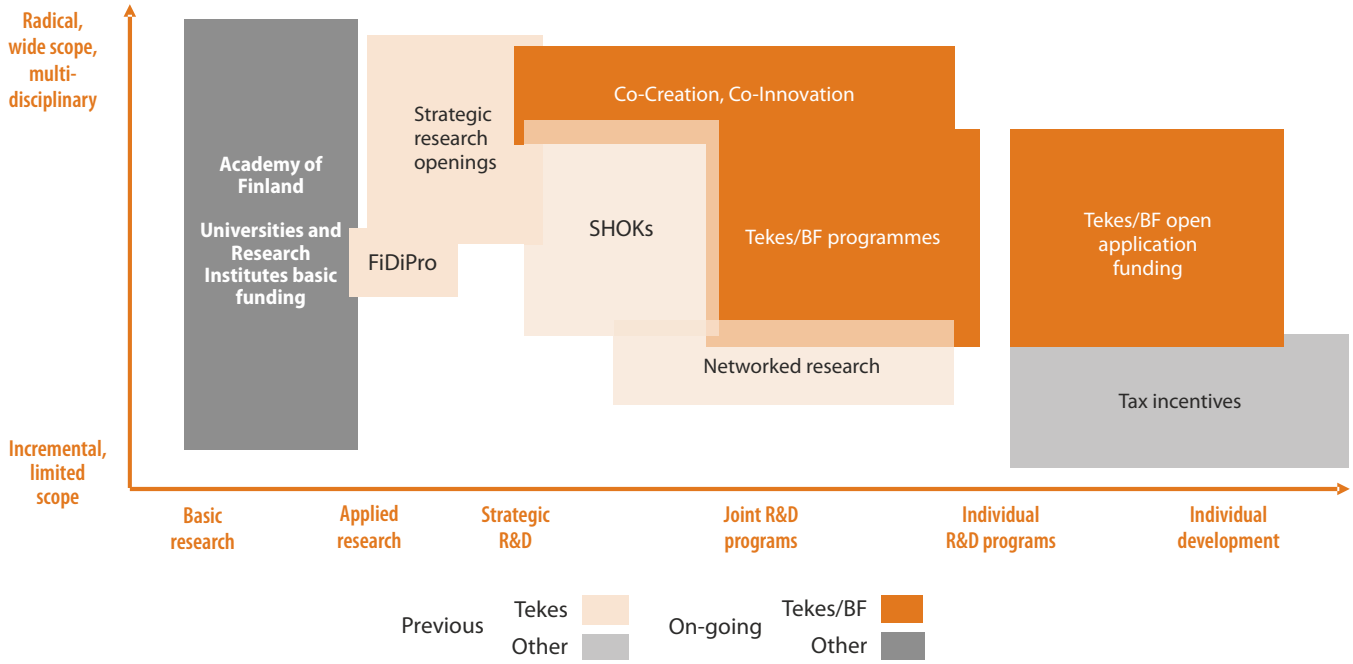
[29] Business Finland, 2018. Funding of research organisations https://www.businessfinland.fi/en/for-finnish-customers/services/funding/research-organisations/in-brief/, Business Finland 2018 Research Funding Services, DM 1992704

The following further illustrates the position of the instruments in terms of their intended purpose or nature. The layout is based on Tekes descriptions of the funding portfolio, which is updated with current instruments using documents and interviews as a source. The observation is that in accordance with the aforementioned changes in Tekes/Business Finland strategy and focus and the ending of the Tekes-era public research funding instruments, the present instruments have not completely replaced them. Overall the balance of Business Finland activities has veered towards the right side of the figure toward innovation, opening a chasm in public funding between academic basic research and industrial R&D and innovation activities. Both by qualitative area of application and funding volumes, the present Co-Creation/Co-Innovation pair does not cover the same area as the previous SRO, EVET and SHOK-funding that ended more or less simultaneously, which is also evident in the figures discussed above.

FIGURE 8. Position of Tekes/Business Finland funding instruments on the continuum from basic research to industrial product development (x-axis) and scope of RDI conducted under these programmes/instruments (y-axis).[30]



[30] Basic layout based on Tekes presentations of public research funding, updated with new instruments and adjusted based on interviews

2.7 FUNDING ALLOCATION FOR THE BIG THREE

The following presents the distribution of funding for the three target groups. The analysis is split between analysis of large enterprises where a large enterprise has been the main applicant/coordinator, research organisations where a research organisation has been a coordinator, group projects where again large enterprise or a research organisation has been the coordinator, and lastly SHOK programmes.

Starting from the group large enterprises, a majority of the funding has been directed to or through a large enterprise. The group large includes also other organisations than private enterprise that qualify as large, but their share of the funding is small. What is not shown in the chart as data was not available, is that large enterprises have had an obligation to use 20 percent of their funding for sourcing services from SMEs and research organisations. In the data set 55 percent of large enterprises have not been further classified, and out of the remaining roughly half were classified as mid-cap -sized by either number of employees (250–499) or by turnover (under 300 million euro a year).

The following table (Table 3) further breaks down the funding to types of instruments or funding services. Out of the total funding for the last 10 years, a vast majority (95 percent) has been for "traditional Tekes projects". By number of ventures, organisational development grants have been popular as well, but their average size is quite small.

FIGURE 9. How Tekes funding for large enterprises has been targeted to different organisation types (Volume = 492 million euro, number of ventures = 1537). Large organisations subgroup includes both enterprises and non-profit organisations.

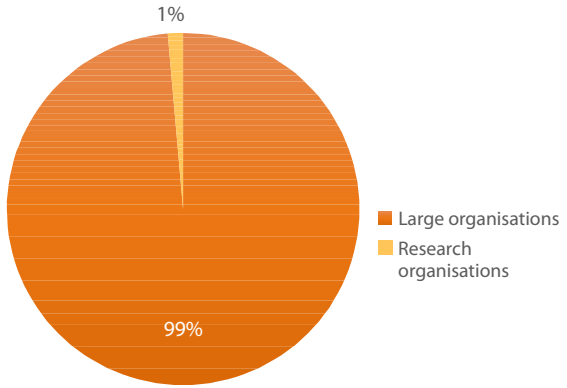


TABLE 3. Tekes funding for large enterprise ventures.

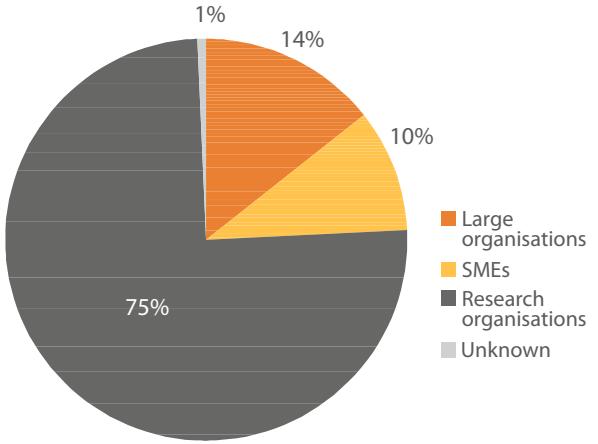
Service/instrument	Number of ventures	Volume, euro
Research and development	1 217	469 513 828
Organisation development	149	10 935 112
De minimis subsidy	86	4 370 251
Energy subsidy	31	811 297
Innovation cluster funding	25	3 638 950
Research	11	1 375 378
De minimis subsidy (SME)	11	646 329
Expert services	5	934 245
Research (Strategic Openings)	2	621 000
Total	**1 537**	**492 846 390**

Compared to the funding for large enterprises, the research organisations are even more monotonous, and the funding has been distributed only for research organisations, including higher education (HEI, including universities, colleges and polytechnics) and public (sectoral) research institutes. Here, again the older research grants dominate in number and volume representing a little more than half of the volume. Between 2015–2017 Tekes funded the networked research projects and strategic research openings. During the time the networked research was approximately twice the size. Here again the numbers conceal the fact that in networked research, the requirement was that the research organisations partner with enterprises, but the enterprises were not granted funding for their participation and is not captured by the funding decisions for the research organisations.

TABLE 4. Tekes funding for research organisations' projects.

Service/instrument	Number of projects/ ventures	Volume, euro
Research	1 095	394 400 829
Research (EVET)	638	151 878 688
Research (SROs)	200	49 406 637
Research, preparation	28	607 647
Total	**1 961**	**596 293 801**

FIGURE 10. How Tekes funding for group projects have been targeted to different organisation types (Volume = 164 million euro, number of ventures = 967).



Going for the group projects, the distribution changes considerably, and only a third of the funding has been directed for enterprises and 14 percent specifically for large enterprises. What is, however, not captured in the data is that the group projects wee to an extent pooled together, and R&D and research projects would proceed in parallel with the consortia working together.

Looking at the instrument breakdown, in group projects approximately half of the total number of projects are research and half research and development, while only 23 percent of the total funding is for R&D projects. As displayed in the comparison table, the total volume of R&D is higher as enterprises have a lower funding rate and invest more collateral funding in the R&D as compared to research organisations.

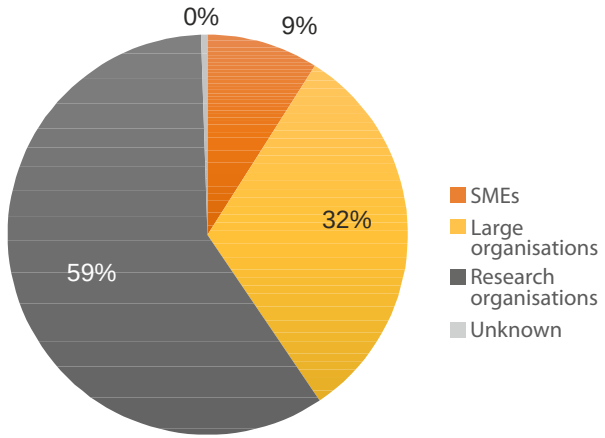
TABLE 5. Tekes funding for group projects.

Instrument	Number of ventures	Volume, euro
Research	469	103 618 042
Research (EVET)	61	13 475 786
Research (SRO)	15	9 785 869
Research and Development	422	38 045 983
Total	**967**	**164 925 680**

The distribution of SHOK funding is similar to group projects, with the exception that here large enterprises and other organisations have a total share of approximately one third of the funding and SMEs 9 percent and the rest is distributed to research organisations. The SHOKs were funded from a specific appropriation, and the key figures are presented below.

The comparison in the Table 5 highlights that the two large groups of projects have been those granted for large enterprises and research organisations. Both by total volume and amount of subsidy. What is different though is that the shares of Tekes funding in the average project is very different. **For large enterprises, the matching or collateral funding whether monetary, tangible or in-kind is approximately double the subsidy, which gives a leverage of 1:3. If we count that depending on the year the amount of loans out of total subsidy is between approximately quarter and third, the leverage would be roughly 1:4**. In group projects and research organisations' projects the ratio is

FIGURE 11. How Tekes funding for SHOKs has been targeted to different organisation types (Volume = 255 million euro, number of ventures = 545).



smaller, approximately 1:2, but in SHOKs the amount of subsidy is much higher in relation.

Another interesting comparison is the size of venture and project, as within a given project, each beneficiary has their own venture. For most ventures, not including research organisations, the average funding is much higher than median, which means that the distribution is skewed and there is a number of very large ventures that heighten the average. E.g. for large enterprises the average is almost a million euro per venture, but half of the funded ventures have had less than 144 thousand as subsidy, which makes the median smaller than average by a factor of 6. The same applies in reverse to the differences in average venture and project for large enterprises. This counter-intuitive pattern suggests that

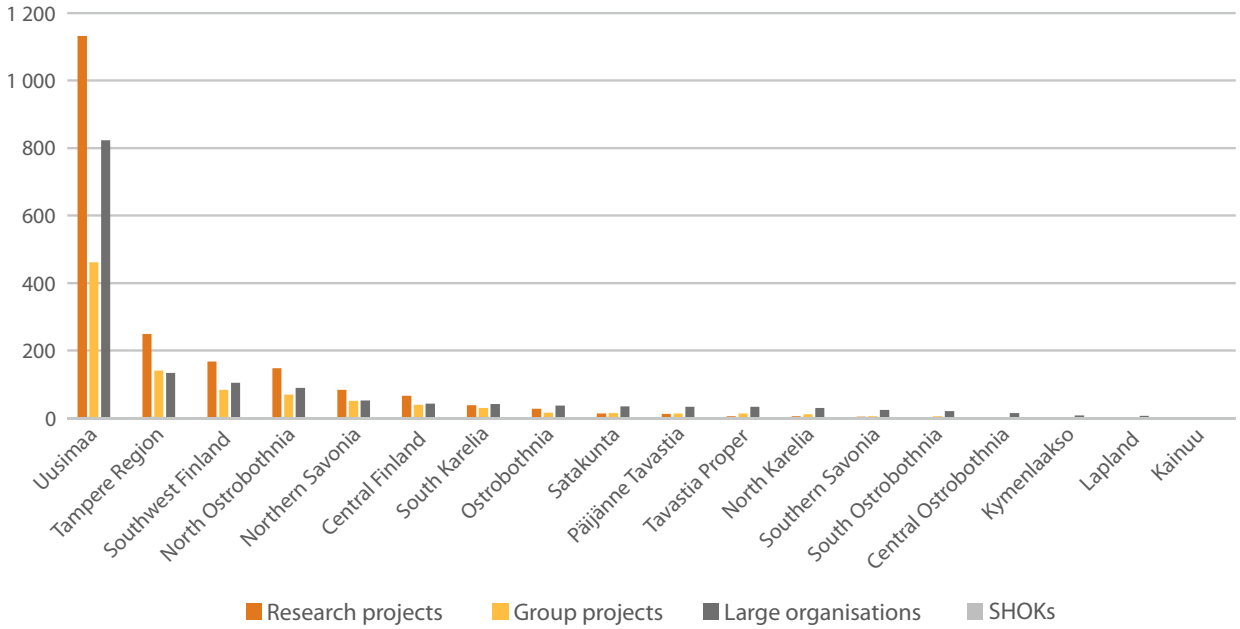
there is a long tail of relatively small projects made out of small ventures capped with a number of very large ventures/projects.

The geographical distribution of funding or ventures is similar between the groups and follows Tekes/Business Finland average. Large city regions are over-represented in the number of grants, with the exception that funding for large enterprises is relatively more evenly distributed between regions.

TABLE 6. Comparison of funding across the target groups.(Source: Tekes/BF funding data)

	Large enterprises	Group projects	Research organisations	SHOKs
Funding totals				
Total funding	1 438 331 419	303 898 680	949 119 769	334 716 501
Tekes funding	492 846 390	164 925 680	596 293 801	255 097 304
Other funding (total)	945 485 029	138 973 228	352 825 968	79 619 197
Averages by venture (applicant)				
Average Tekes funding per venture	935 804	570 677	304 076	468 068
Average other funding per venture	615 149	480 876	179 921	146 090
Median Tekes funding for ventures	144 000	106 712	208 000	161 493
Averages by project				
Average funding per project	1 172 234	1 113 181	487 227	18 595 361
Average Tekes funding per project	401 667	604 123	306 105	14 172 072
Share of Tekes funding in an average project	34 %	54 %	63 %	76 %
Average duration of a project	2.7	3.1	2.9	3.9
Average number of partners in a project	2.0	1.1	2.1	30.3
Number of ventures	1 537	289	1 961	545
Number of projects	1 227	273	1 948	18

FIGURE 12. Geographical distribution of ventures by programme type. (N=5010, unknown=10).



3 LESSONS FROM THE NETHERLANDS AND SWEDEN

The following section summarises the findings from a learning exercise directed towards funding programmes for ecosystems. Two examples were chosen with the steering group for a closer look: Topsectoren from the Netherlands and the Strategic Innovation Programme (SIP) from Sweden. The purpose here is to highlight learning from programme structure and management for future ecosystems-building instruments.

3.1 TOPSECTOREN IN THE NETHERLANDS

The specific target for benchmarking from the Netherlands is the Topsector approach. The approach of Topsectoren was rooted in the current Government's ambition to raise the Netherlands' profile as an innovative economy by investing in key economic sectors or industries on the one hand. On the other, it was also an effort to concentrate and coordinate innovation policy. In the Dutch Government's ambition and vision, globalisation in relation to a dynamic world economy is seen as an opportunity for businesses. Societal challenges, such as an ageing population, an increasing scarcity in raw materials, climate change and diminishing biodiversity, can be regarded as opportunities too. The main objectives for the Topsectoren can be summarised as:

- The desire to leverage fiscal policy as a replacement for subsidies and grants
- The desire to use regular financing to encourage public-private partnerships
- The desire to reduce fragmentation in innovation policy
- The desire to increase the involvement of various ministries other than the Ministry of Economic Affairs
- Create scope within the triple helix of businesses, research institutes and government to develop a shared vision and to work on common objectives with respect to knowledge and innovation, internationalisation, human capital and reduction of the regulatory burden.

Other key objectives of this top sector policy are the demand-driven input from the private sector, providing a

greater scope for entrepreneurs as well as the shift from specific subsidies to more generic deregulation and reduction of business taxes.

The choice for a top sector approach was made in relation to certain characteristics of the Netherlands. Geographical factors such as the country's location in north-western Europe and the country's long-lasting special relationship with water have ensured a multitude of activities in the logistics sector as well as in water management, agri-food, chemicals and high-tech systems.

Topsectoren is a mixture of top down and bottom up processes. The industry and science community in the selected top sector fields have room for own ('bottom up') activities within their sector, and the different Topsectoren have an independent management system giving the stakeholders a lot of freedom to develop tools for supporting their different areas and sectors. The annual government budget is of approximately 1–1.1 billion euro for nine Topsectoren.

The Topsectoren have been evaluated both regarding its management, results and effects. All evaluations judge the programmes as successful although most evaluations also included suggestions for improvements. In the 2014 evaluation of the Topsectoren it was concluded that it was too early to measure tangible effects, but that the ***top sector approach had given rise to new dynamism in the Dutch economy, with many parties entering into dialogue and self-organisation in top sectors***.

In 2016, it was concluded that the development of the top sector approach has spawned innovative ways of working in various economic domains and was bearing fruit. It was recommended that the top sector policy should be continued and that it should be developed further. The next year, in 2017, a comprehensive evaluation of the Topsectoren was performed. It concluded that the ***top sector approach has been effective in the more demand-oriented programming of public-private-partnership research projects at Dutch knowledge institutes, aligning human capital activities and promoting export***.

The introduction of the top sector approach meant a significant change to the overall system: the focus switched towards a sector-based and integrated approach, in which a new way of financing and organising consortia puts a greater emphasis on demand-driven aspects. Hence, the government's role has evolved, from management-by-subsidy to network management. The government acts as a matchmaker bringing parties together, as a co-investor, as a driver of innovation and as a facilitator working to cut through red tape. Furthermore, the government works on reduction of the regulatory burden and on a better alignment between the demand and supply of qualified personnel in these key sectors.

In addition to the Ministry of Economic Affairs and Climate Policy, other ministries are involved in the top sector policy as well. These ministries include the Ministry of Education, Culture and Science, the Ministry of Health, Welfare and Sport, the Ministry of Infrastructure and Water Management and the Ministry of Agriculture, Nature and Food Quality. For each top sector, one min-

istry serves as contact point and is responsible for the contribution to that sector. As an example, the Ministry of Health, Welfare and Sport is a member of the Top team of the Life Sciences and Health top sector, representing the government in this Top team. The Knowledge and Innovation Contract for this sector has been established by industry and research organisations in consultation with several other top sectors, several regions and their science parks, and the relevant ministries.

The top sector approach has resulted in a lot of new knowledge development and has contributed to the emergence of new and dynamic (public-private) partnerships. In order to achieve more ground-breaking innovations increased multidisciplinary- and cross-sector collaboration will be emphasised in the coming years. Hence, in this respect the Dutch policy will shift in the direction of the approach in Sweden and Denmark. Furthermore, one must realise that a fruitful cooperation within the triple helix doesn't happen automatically and doesn't happen overnight, hence, depending on the (business) practices and culture in a country, this might require special attention and an investment in time.

CASE **TOPSECTOR ENERGIE**

The Topsector Energy (TSE) is the driving force behind the innovations needed to make the transition to an affordable, reliable, safe and sustainable energy system. The TSE supports business, knowledge institutes, government and social institutions to collaborate towards the energy system of the future.

The Topsector stimulates new initiatives that accelerate the transition towards sustainable energy, creating new activity and the strengthening of the international competitive position of the Netherlands.

The TSE focusses on the goals towards 2050 as stated in the National Energy Agreement, the Energy Agenda and by the EU member states. The aim is to achieve a fully sustainable energy supply and a CO2-reduction of 80–95 percent as opposed to the situation in 1990 by 2050. This gives direction to the innovations the Topsector stimulates. In the Energy Agenda four energy functions have been determined with corresponding transition paths. In 2017 these transition paths will be elaborated further. The Innovations of the TSE support the transition paths following THIS coherence.

The top team is the daily management of the TSE and carries the final responsibility for the TSE. The top team consists of a figurehead from the energy sector, a science-representative, a top civil servant and an innovative SME entrepreneur. The direction-team consists of leading stakeholders in the energy sector, hailing from business, knowledge institutes and social institutions. The Topsector Energy collaborates with the Energy research Centre in the Netherlands (ECN), the Netherlands Organisation for applied scientific research (TNO), the Netherlands Organisation for Scientific Research (NWO) and several universities.

▶▶

FIGURE 13. Structure of Topsector Energy.

Topsector Energy consist of 5 consortia for Knowledge and Innovation (TKI). TKI Bio-based Economy focusses on bio-based innovations throughout the biomass value chain. From the field to the end-product, including recycling of industrial and household streams. TKI Energy and Industry contributes to the sustainability goals of the process industry through the generation and application of new knowledge in collaborations and demonstration programs. TKI New Gas organizes a gas sector wide systematic approach for innovations that build on the strong (knowledge)position the Netherlands traditionally has in the fields of exploration and production, transportation and trade, and (end)applications of gas. TKI Urban Energy promotes, connects and supports Dutch companies and knowledge institutes om the development and application of innovations towards a rapid transition towards a sustainable, reliable and affordable energy system in the urban environment and infrastructure. TKI Wind op Zee facilitates research, development, demonstration, knowledge transfer, (international) collaboration and market development aimed towards maximizing cost reduction and economic impact.

3.2 STRATEGIC INNOVATION PROGRAMME IN SWEDEN

To put the programme in context, research and innovation have been high on Swedish agenda since end of the 1990s, which is also reflected in the development of funding, and consequently R&D intensity has almost doubled since 1998.[31] The Swedish state funding for R&D in the state budget is estimated at SEK 37.5 billion in 2018. This corresponds to 3.7 percent of the total state budget. Organisations for higher education, universities and colleges, receive the largest proportion with 49 per cent of total R&D funding. The research-funding agencies (Vinnova, The Swedish Research Council, Formas and Forte) receive by 29 percent, and other agencies 18 percent. Within this budget, general advancement of science and academic research was allocated approx. 70 percent of the total R&D funding in 2018. Universities and colleges and the Swedish Research Council are the main recipients of these funds. The largest area of research in terms of funding, is life sciences that constitutes just under one quarter of the total R&D budget, followed closely by mathematics and natural science.[32] In the more applied side of RDI, the strategic innovation areas highlighted by the Government of Sweden in 2016 are:[33]

- Next Generation Travel and Transport
- Smart Cities
- Circular and Bio-based Economy
- Life Sciences
- Connected Industry and New Materials

Collaborative research has received an increasing interest in the research policy bills from 2008, 2012 and 2016[34]. Starting in 2008 with the introduction of strategic research areas, 2012, strategic innovation areas and 2016 collaboration programs, as described in more detail below. Another indicator for the Swedish interest for collaborative research is the budget for agencies mainly supporting collaborative research. Two of the largest are Vinnova and Swedish Energy Authority that has a specific mission to support RDI on energy saving and renewables.

Overall, following the Swedish research policy bills for 2008, 2012 and 2016 and the development of the spending on R&D for Vinnova and the Swedish Energy Agency both general focus on and funding for collaborative and need driven research and development have

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31 https://www.scb.se/hitta-statistik/artiklar/2017/Regeringen-satsar-37-miljarder-kronor-pa-FoU-2017/

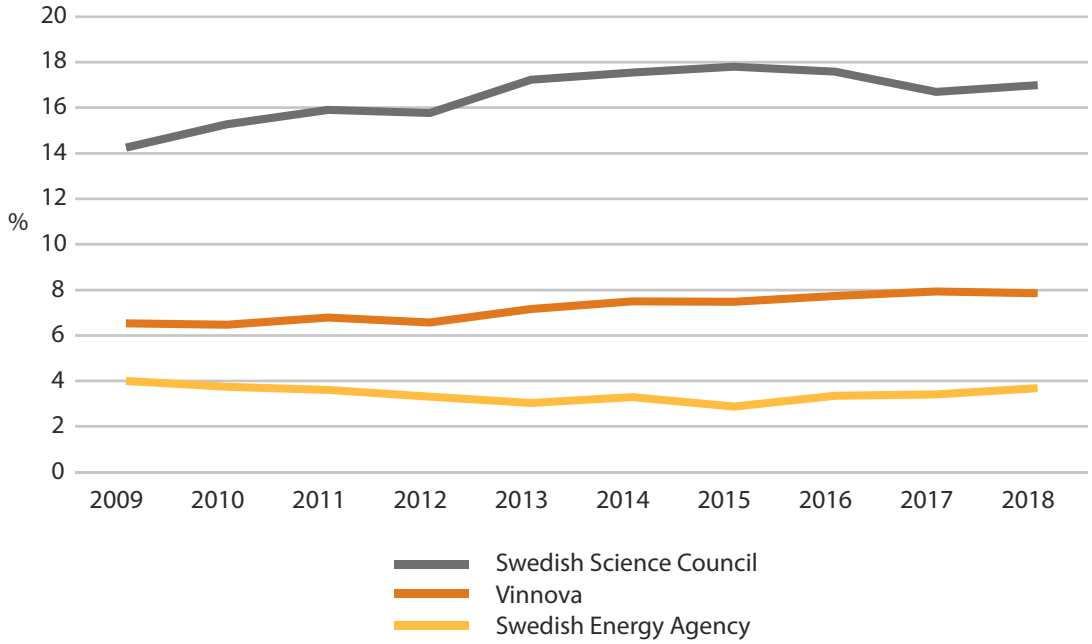
32 The Swedish statistical nomenclature for research includes areas: Medicine and health science; Mathematics and science; Social science; Humanities; Agricultural Science, c.f. https://www.scb.se/hitta-statistik/statistik-efter-amne/utbildning-och-forskning/forskning/statliga-anslag-till-forskning-och-utveckling/pong/statistiknyhet/statliga-anslag-till-forskning-och-utveckling-2018/

33 Statistics Sweden, State investment in Research and Development, Available: https://www.scb.se/hitta-statistik/statistik-efter-amne/utbildning-och-forskning/forskning/statliga-anslag-till-forskning-och-utveckling/pong/statistiknyhet/statliga-anslag-till-forskning-och-utveckling-2018/

34 The Government of Sweden, Research Bills of 2008, 2012, 2016 Available: https://www.regeringen.se/rattsliga-dokument/proposition/2008/10/prop.-20080950/; https://www.regeringen.se/rattsliga-dokument/proposition/2012/10/prop.-20121330/; https://www.regeringen.se/rattsliga-dokument/proposition/2016/11/prop.-20161750/

been reinforced, which marks a departure from the Finnish stance towards RDI policy in recent years. As already mentioned, in 2018 the Swedish public budgetary allocation for R&D amounted to more than SEK 37 billion. Since 2008, the total amount of public funding for R&D has increased by 24 percent, adjusted to 2018 prices. The research budgets for the Swedish Energy Agency increased by 10 percent (2009–2018) and for Vinnova by 38 percent (2008–2018).

FIGURE 14. Development of the share of R&D funding by the three funding agencies out of total GOVERD.[35]



It should, however, be noted that the support for collaborative RDI has not come at the expense of basic research. On the contrary, also basic research has received a substantial increase in funding during the period of 2008 to 2018. The following figure (Fig. 14) illustrates the budget development for Vinnova, The Swedish Energy Agency and the Research Council, the latter being the main funding organisation for basic research. As can be seen the Research council's share of public spending on R&D has increased more than Vinnova.

The Strategic Innovation Programme (SIP) is on of key initiatives for supporting collaborative RDI in Sweden. Structurally it is a combination of top down and bottom up approach. The annual government budget made available for the SIP is approximately 50 million euro.

Strategic innovation programmes are developed through strategic innovation areas, a bottom up process, in which a group of stakeholders could apply for funding for formulating a strategic innovation agenda in which common vision and goals for an area defined by the stakeholders were developed. Under the SIP originally development of 130 agendas were funded. Out of these 130 agendas describing 130 strategic areas, 17 strategic innovation programmes were selected to be funded to become the SIPs to support these innovation areas.

[35] Estimates based on numbers from Statistic Sweden and annual reports for the Swedish Energy Agency

The main objectives for the Strategic Innovation Programmes are

- Economic growth and job creation in Sweden
- Create collaboration between academia and industry
- Create demand driven projects
- Contribute to the solution of societal challenges
- The stakeholders (industry, academia and public organisations) in each strategic innovation programme develop a shared vision and to work on common objectives.

The strategic innovation programmes have an independent management system giving the stakeholders a lot of freedom to develop tools for supporting their different areas and sectors.

The first two generations (11 out of 17) strategic innovation programmes have been evaluated regarding their management.

The evaluation of the first generation concluded that while the SIPs were quite different from each other, they were on the right track in building up collaboration between stakeholders.

The overall conclusion was that the first five ***SIPs succeeded in establishing actor-driven activities and managed actors to join forces in areas of innovation that are strategically important for Sweden***. It was noted however, that the link between the activities and especially long-term impact target needed to be clarified. The evaluation suggests the programmes to actively work with the programme logic and also ensure that the project portfolio meets the ambition level pursued by the programmes. Another main recommendation was that links to international partners should be strengthened, and it is estimated that many programmes not yet had reached the degree of internationalisation that should be pursued.

In the evaluation of the second-generation programmes, the programmes had reached all the important stakeholders. The second-generation programmes were also very different in nature and some were based on a narrow topic bringing together a small number of already known actors, while others gathered a larger consortium of partners previously unknown to each other. The evaluation found the ***programmes to be open and transparent and they were addressing important societal challenges, albeit with different approaches***. The evaluators concluded that the programmes can be helped in the development of the programme by using a clear impact logic. In summary, the evaluators noted that the programmes had a strong development the first three years, overall the programmes were judged to be on the right track.

CASE **SIP INFRASWEDEN 2030**

InfraSweden 2030 is a strategic innovation programme that will contribute to the development of the transport infrastructure of the future. The key words are integrated and sustainable solutions, system perspective and global competitiveness. The main focus in the programme is on an innovative and multidisciplinary approach and a bottom-up-strategy for innovation. The basis for the programme is the GIMI agenda that came out in 2012.

A lot of the key players in Sweden with connections to the transport infrastructure already participate in InfraSweden 2030, which plans the ventures within different focus areas through open announcements, individual projects, networks and events.

InfraSweden 2030 has two objectives: To double the sustainability in the Swedish transport infrastructure and to make Sweden a world leader in innovative infrastructure solutions by 2030. The programme is financed via Vinnova, the Swedish Energy Agency and Formas. The programme enables strategic innovation by linking road and rail technology with the latest in materials, automotive and communication technology, as well as standardisation. InfraSweden2030 is administered via KTH. In the programme, companies, organisations, colleges and other key players from the infrastructure industry collaborate. In order to find innovative and creative solutions, players from other industries will also be invited.

The operation of InfraSweden 2030 concentrates on the following focus areas:

- Climate-neutral transport infrastructure
- Integrated infrastructure networks in society
- Design solutions and construction methods for a sustainable and secure transport infrastructure
- Increased transport infrastructure productivity for better social benefits
- Permit assessment and operation and maintenance methods.

InfraSweden2030 is a member-driven innovation programme. The members appoint the programme board, which supervises the work of the programme management team. The daily operations are handled by the programme agency at KTH.

The main activities of InfraSweden 2030 include the following:

Seminars and meetings
Every year, InfraSweden2030 conducts several seminars and conferences with different themes in the transport infrastructure area in order to gather stakeholders and initiate collaborations. The themes are initiated by working with our members and are related to the focus areas.

Calls for research and innovation projects
InfraSweden2030 supports Vinnova when it comes to targeting and designing calls for funding research and innovation projects for smart, sustainable and competitive transport infrastructure. The calls contribute to developing innovations in the Swedish transport infrastructure.

Strategic research and innovation projects
Through analyzes of the area, external monitoring and with the support of our members, InfraSweden2030 recommends Vinnova to finance a small number of projects within strategically important areas for transport infrastructure.

3.3 COMPARISON BETWEEN ECOSYSTEM POLICIES

Topsectoren is a top-down programme with nine focus areas along with established industry borders. The seventeen Strategic Innovation Programmes on the other hand is more of a bottom up approach, where in principle any consortium could develop a strategic innovation agenda and apply status and funding. The programmes are also very different in scale, with the Topsectoren having a yearly budget of approximately 1 billion euro between the 9 Topsectoren, the SIPs have 50 million euro between 17 SIPs.

Common between the programmes is that in both the consortia develop a strategic research or innovation agenda or a roadmap between the stakeholders. Another similarity is the independent management system give the stakeholders a lot of freedom to develop their different areas and sectors.

Other commonalities include that the programmes have an overarching objective to contribute to solving societal challenges in combination with economic growth and job creation in the Netherlands and Sweden. The orientation is taking societal challenges such as an ageing population, an increasing scarcity in raw materials, climate change and a diminishing biodiversity, as possible opportunities for innovation and new business.

Both programmes also have a connection to ministries, although the Topsectoren seems to have more direct and developed connection with the Dutch government acting as a matchmaker bringing parties together, as a co-investor, as a driver of innovation and as a facilitator working to cut through red tape. Furthermore, the government works on reduction of the regulatory burden and on a better alignment between the demand and supply of qualified personnel in these key sectors. In Sweden the introduction of strategic collaboration programmes, in which the collaboration programmes develop top down strategies partly being implemented through the SIP. Thus, the Strategic Collaboration Programmes could be considered to act as channel between the Government and the SIP.

The following table contextualises the findings from SIP and Topsectoren in relation to the closest equivalent in Finland, the SHOK programme. In many respects the SHOKs fall in the middle of the other cluster/ecosystem schemes. The major differences are that facilitation/governance is in many SIPs and Topsectoren handled by the relevant existing Industry Associations, while the SHOKs were entirely self-governed private enterprises. What separates SIPs is that the selection programme has been open, first the prospective consortia submitted a proposal Strategic Innovation agenda, which turned into a Programme when chosen for funding. Additionally, the SIPs can be perhaps seen more as platform for collaboration and coordination, less a funding source all on its own, as opposed to the other two.

TABLE 7. Contextualisation of the SIP and Topsectoren.

Dimensions	SIP	SHOKs	Topsectoren
Policy rationale	Economic development and job creation Solving societal challenges	Renewal of Finnish industry and key economic sectors Growth and jobs	Reinforcing innovation and internationalisation of industry Capturing the opportunities offered by global societal changes
Selection	Open process for proposing strategic innovation agendas/areas, funding agency chose the ones to fund	Selection of key industries based on longer standing industrial and cluster policy	Selection of key industries based on longer standing industrial and cluster policy
Governance and structure	Self-governing SIPs, often in conjunction with industry associations. Governance/steering by Vinnova and Formas	Self-governing SHOK enterprises steered by the SHOK Steering Group and funding agencies	Topsectoren are governed largely by Industry Associations and steered by Ministry of Economic Affairs and sectoral ministries
Instruments/ incentives	Vinnova and Formas jointly fund the SIPs 17 SIPs, 50 million euro/y	SHOKs were able to apply funding from various sources. In practice the main source was Tekes budget appropriation 6 SHOKs, 80–90 million euro/y	Topsectoren are funded by the Ministry directly through MITb scheme and (indirectly) through tax breaks, and participants can apply for various subsidies 9 Topsectoren, up to 1 000 million euro/y
Content areas/ themes	Over 17 programmes: Process and industrial automation, Industry 4.0; Lightweight materials and structures, biomaterials; minerals extraction and refinement; IoT and smart electronics; transportation and aerospace; life sciences and healthcare innovation processes, health-tech; smart cities	Over six (original)/three SHOKs: forest-based biomaterials; health-tech, diagnostics and monitoring; energy efficiency, sustainable energy production; smart cities; communications technology, IoT; Industry 4.0, technology and processes for networked production; metals production and processing	Over nine Topsectors: resource efficiency and sustainability in food system, digitalisation in agriculture; water technology, water management and maritime construction; 'high-tech' materials, photonics and electronics, and embedded systems for automotive, aerospace and healthcare; sustainable energy; sustainable transport and logistics; creative industries and design, with cross-over themes: ICT/digitalisation, nanotechnology and bio-economy

Comparing the various themes or content areas, these naturally reflect national policy priorities to some extent, for example the Topsectoren has a strong focus on agri-business and SIP has committed attention to aerospace and transport. However, the common themes are with various emphasis light-weight, high-tech or otherwise advanced materials (2/3), general sustainability, energy- and resource-efficiency (2/3), bio-based materials (2/3), smart cities, IoT and other technologies implemented to urban planning, transport and logistics, healthcare and life-sciences, and general digitalisation, industrial internet and Industry 4.0.[36] As such the priorities of SHOKs reflect earlier themes and priorities of the constituents, while in SIP and Topsector the present themes are very similar to for example Finnish RDI policy themes with the mentioned differences in national priorities.

[36] For industry 4.0, see e.g. BMBF, 2013 Umsetzungsemfehlung für das Zukunftsprojekt Industrie 4.0, https://www.bmbf.de/files/Umsetzungsempfehlungen_Industrie4_0.pdf; BMWI, BMBF, Platform Industrie 4.0 https://www.plattform-i40.de/I40/Navigation/DE/Home/home.html

4 IMPACT OF TEKES FUNDING

This section presents the main data and findings organized by the three target groups specified for the study, large enterprises, research organisations and SHOKs. As a note, the analysis, as discussed, is conducted at the project level, and the group SHOKs includes projects/ programmes executed under the umbrella of SHOKs, the findings do not reflect the views of the SHOK companies but the project participants. The section ends with discussion of the overall systemic impact of funding and summary of the case studies conducted for this project.

4.1 LARGE ENTERPRISES – increased competitiveness through new products, services, expertise and broadened networks

A major objective according to the surveyed enterprises was "to develop new or improved products", "to solve specific problems" or "to develop expertise". Behind these items come expertise and new technology, which means to say the projects are relatively more often product focused and short-to-medium term than long-term technology focused.

The next figure (Figure 16) presents the items regarding collaboration separately. Overall collaboration is important for most participants but focus on solving problems and developing products or services is still a top priority. It is evident that collaborating nationally with other enterprises or research organisations is a higher priority than international collaboration. When comparing small and large enterprises only minor differences can be observed for the objectives.

In terms of the results and outcome of the projects for the enterprises new knowledge, competence development and new or improved technology were the close term results. For many also increased interest from management was reported. Despite the focus on products and services, less than half of the projects resulted in new devices or equipment directly and a little more than half in the long term. The main difference between large enterprises and SMEs is that scientific publications, development of new improved technology and

FIGURE 15. To what extent were the following objectives important for your enterprise to participate in the project?

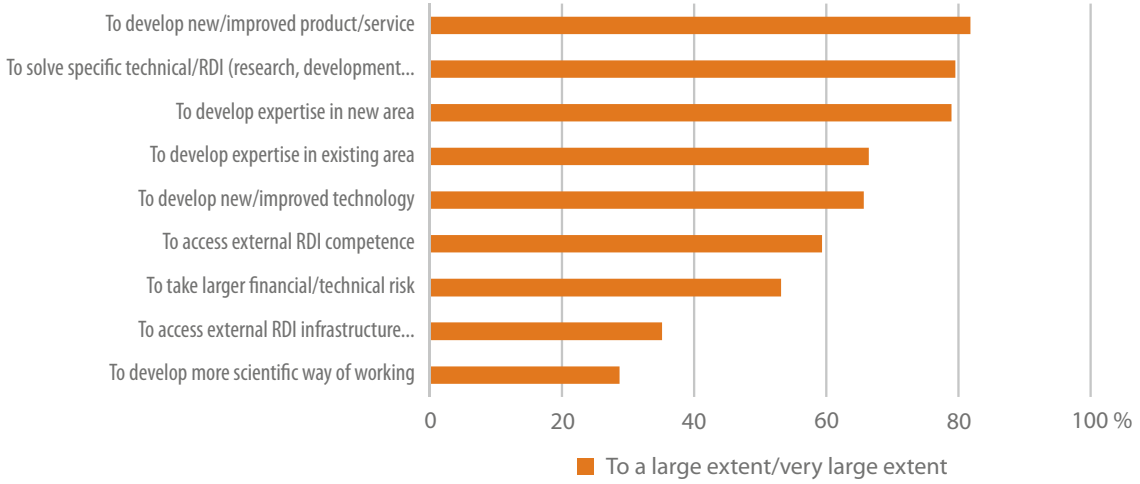


FIGURE 16. To what extent were the following objectives important for your enterprise to participate in the project, collaboration?

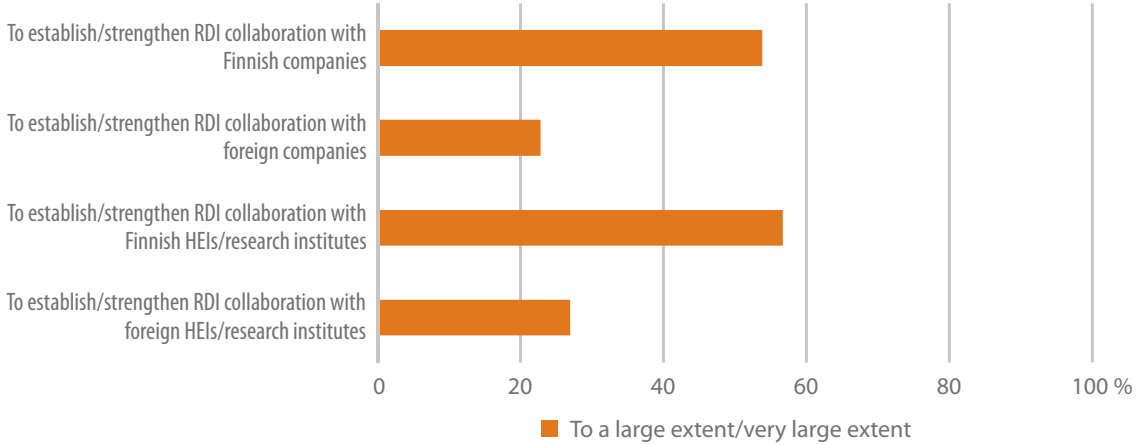
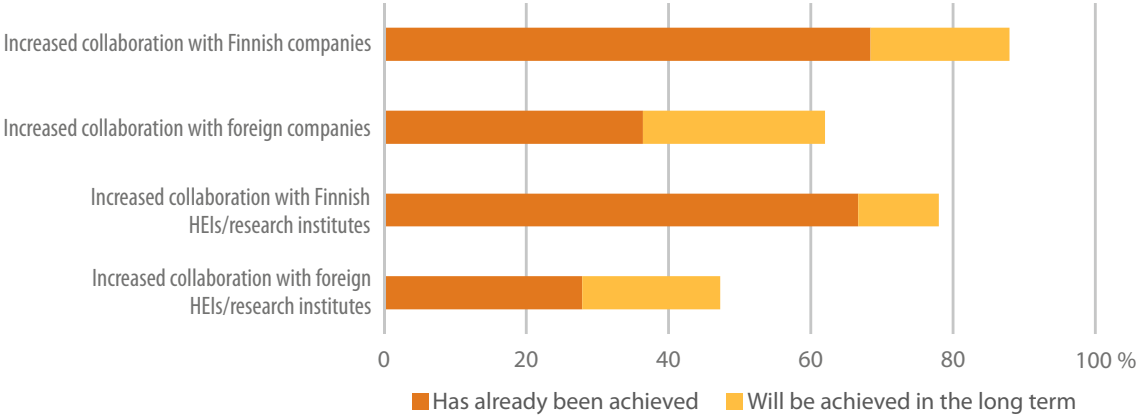


FIGURE 17. What has the project has resulted/will result in for your enterprise?

FIGURE 18. What has the project has resulted/will result in for your enterprise, collaboration?



patent applications are more common results for large enterprises than SMEs.

Another major result was increased collaboration nationally, roughly the same portion that put it as an important goal also achieved it. Collaboration between enterprises is a more common result than collaboration with research organisations.

In regard to the outcomes and impacts, they are rather product, service or process focused. The most common realised outcomes in over half of the cases include pilots and demonstrations, products, services or processes and improved RDI capability. In the longer term, new business and technology areas are raised to parallel the former and the outcome in the long term is a new product or service, or a new business or technology in four cases out of five. Besides new RDI areas or specialties and processes, the beneficiaries experience or expect relatively few outcomes in terms of internal development or behavioural additionality, as management practices and business models trail behind.

Out of the more abstract impact, in a little less than half of the projects the impact is increased competitiveness compared to foreign enterprises, new domestic partner or supplier and increased competitiveness compared to domestic enterprises. Again, in roughly every four out of five projects the expectation is that in the long run the impact is increased international competitiveness, increased turnover and profitability. Increased exports and employment trail slightly behind at over 60 percent. This signals that the tangible impact is expected in a relatively long timeframe after the project ends.

FIGURE 19. What kind of (long-term) impact the project has had/will have on your enterprise?

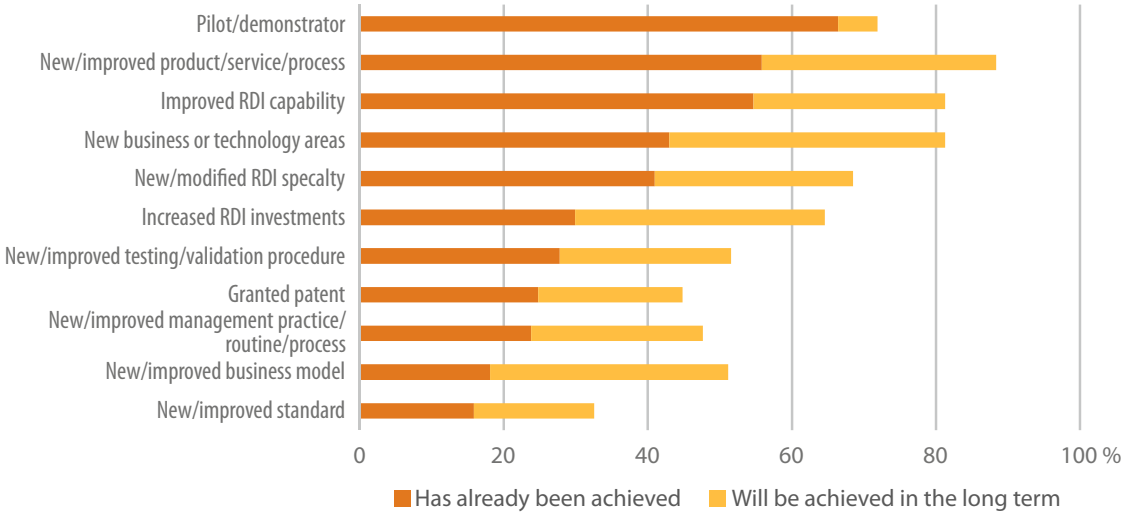
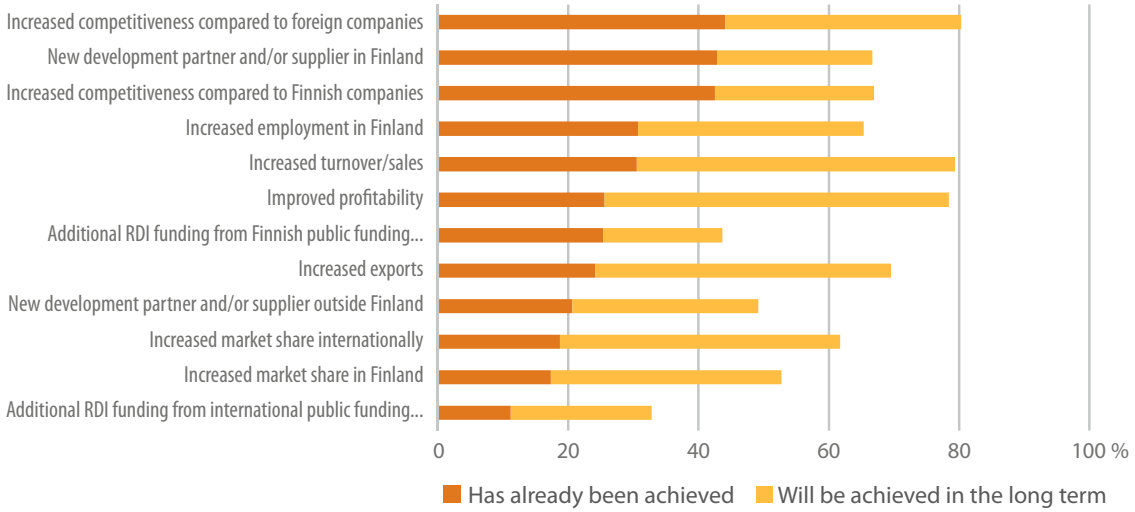


FIGURE 20. What kind of (long-term) impact the project has had/will have on your enterprise?



Also, interestingly, relatively few, only approximately one in five, beneficiaries expect increase in market share despite increase in competitiveness. This signals that the RDI projects are to defend existing segments or possibly to create new markets.

The case studies reinforce the findings from the survey. First of all, the funding and the risk-sharing it provides, has enabled undertaking larger and more ambitious projects for the enterprises. Additionally, the Tekes desk officers have provided insights and coaching for project scoping, selection of partners and evaluation of development options. In the outcome, besides the tangible outcome, the projects have also had behavioural additionality in helping adopt new processes, practices or methods, and creating new innovative culture. In the systemic dimension the projects have introduced new partners and created broader networks. In the impact, the bottom line is that the development has contributed to reinforcing positions and competitiveness on the market.

TABLE 8. Additionality of Tekes funding for large enterprises as viewed by the case study subjects.

	Large enterprises
Input and process additionality	Tekes funding has created an opportunity to realise **larger and more significant development projects**. Business Finland expertise has created value in scoping the projects, selecting partners and evaluation technological options.
(Anticipated) project outcomes	New technologies, products and increasingly services. Additionally, the products helped create cultural changes in house and adopt new practices and ways of working,
Output additionality	The project (-s) would have proceeded in some form or another, but the funding **raised the level of ambition** and effort, the projects were more "in-depth" and broader or deeper in scope and resulted in a more useful outcome. The project outcomes helped the beneficiaries reinforce their position in the market and stay competitive.
Systemic impact	The projects have **broadened networks**, introduced new partners to each other.

CASE VALMET DNA – NEXT GENERATION AUTOMATION SYSTEM

The Valmet automation system has a long history. Already in 1970's the first digital version of Valmet automation system was launched. After the second-generation automation system version at the end of 1980's, development of the system has been evolutionary. The need for major reform was obvious, and not only because of the new technological opportunities like IoT and AI. The project concentrated on the evaluation of different potential technologies and the start phase of actual R&D work.

Valmet third generation automation system project (2013–2017) was Valmet's biggest R&D project. Valmet utilized the expertise of start-ups and SMEs specialized in new digital technologies. As a result of the project the first dashboard solutions of the new generation Valmet DNA automation system were launched in September this 2018.

The project was crucial of the existence of Valmet's automation system business. Without the investments made, it would have been impossible for Valmet to be competitive in global markets. It can be argued that the ***project secured the future for Valmet automation business.***

The project also brought along ***new expertise and partners for Valmet***. It increased the expertise related digital solutions inside Valmet, and this expertise was also leveraged to other product lines. The project started during a time when Tampere region suffered massive lay-outs of Nokia. For Valmet it meant that there were potential loT expertise available and new start-up companies were born with the help Nokia Bridge programme. Valmet started to cooperate with some of these companies, and still has an ongoing cooperation with the key partners. For those companies, having Valmet as partner, meant an outstanding reference, and in some cases even opened doors for internationalisation. Thus, it can be argued that the project also ***enhanced development of Tampere ICT ecosystem***.

The project has also resulted in over hundred invention closures and less than 10 patents. During the project the licensing has increased as many components are open source components.

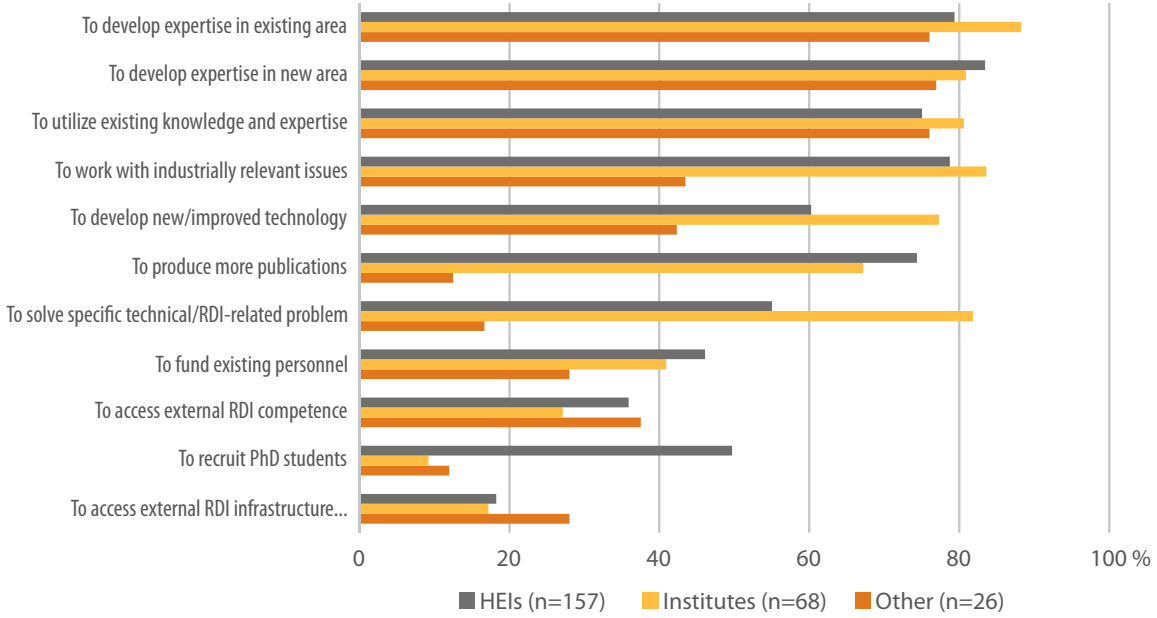
Valmet would have started the project without Tekes' contribution, but the extent of the project would have been more limited and the pace slower, and Valmet would not have been able to utilize the outside expertise and partner network to extent it now has.

Beside the monetary contribution the expertise and networks of Tekes have been helpful. Especially in selecting the technology and building the security solutions, Valmet has utilized the expertise Tekes' experts possess. Regularly meetings and increment reviews, to which Tekes participated, served as platform for sparring and discussion.

4.2 RESEARCH ORGANISATIONS – creation of new research prorammes, platforms and business areas

The following figures show the results for HEIs, research institutes and other organisations (including mostly public actors). As can be seen from the figure below, the major objectives are to "develop expertise", "utilise existing knowledge" but also "to work with industrially relevant issues". An interesting observation is that an objective nearly equally important for both HEIs and research institutes is "to work with industrially relevant issues", while for the other (public) organisations it is not very important. Particularly for research institutes solving specific technical or other RDI-related problems is a common goal, which is corresponds to the case studies as discussed below.

FIGURE 21. To what extent were the following objectives important for your organisation to participate in the project?



To highlight the collaboration component of this question, the next figure again focuses on the collaboration. A clear pattern is the dominance of the objective "to strengthen RDI collaboration with Finnish enterprises". The least often chosen objective is "to strengthen RDI collaboration with foreign enterprises". Both Finnish HEIs and research institutes have participated in Tekes projects to make use of the possibility to collaborate with Finnish enterprises.

Also, the survey shows that new research questions are an important result for the HEIs and the research institutes. An interpretation can then be that the collaboration with enterprises created input from the enterprises to the HEIs and research Institutes for creating new research questions that in turn resulted in further research. In this context, the difference between HEIs, research institutes and companies are noteworthy. 75 percent of HEIs and 74 percent of the research institutes have indicated "new research questions" as a result in comparisons to 43 percent of the enterprises.

FIGURE 22. To what extent were the following objectives important for your organisation to participate in the project?

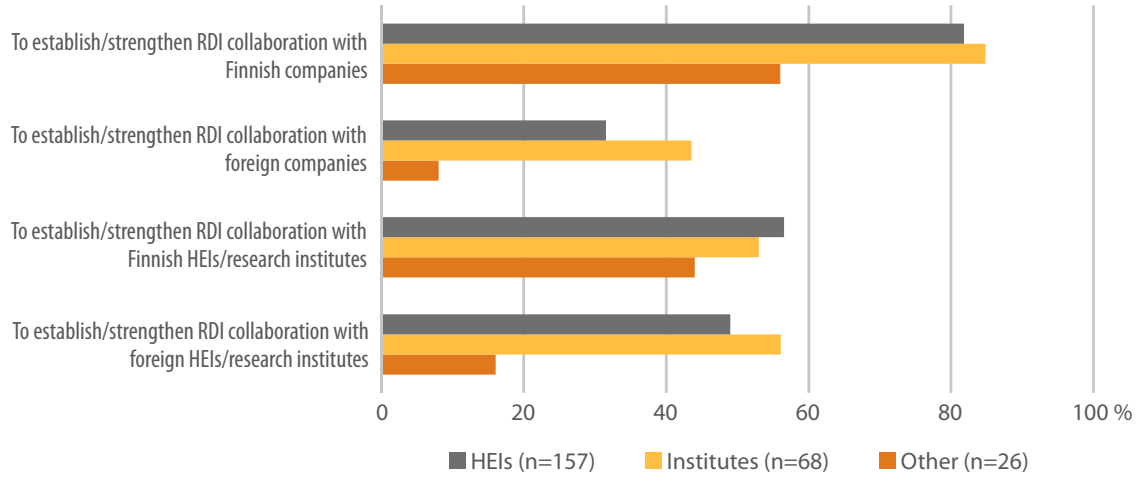
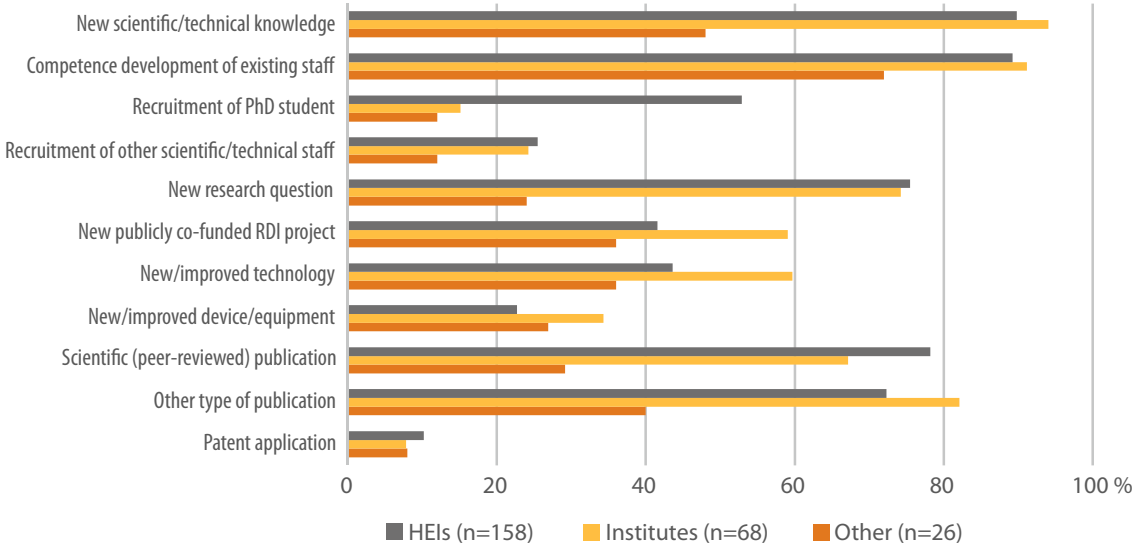


FIGURE 23. Please assess what the project has resulted/will result in for your organisation.



It is also interesting to note that 45 percent of the HEIs declare "pilot/demonstrator" as a long-term impact of the Tekes funded projects. The corresponding number for the research institute is 55 percent. This again can be interpreted, as described above, as input from enterprises creating pilots and demonstrators at the HEIs and research institutes. Not to forget pilots and demonstrations are an important part of the research process as they offer empirical insights and data to the researchers.

The case studies broaden the view to contribution of Tekes research funding. Tekes has had a key role in the innovation system in initiating and funding applied and industrially relevant research in areas that do not have an established industry or business area and that fall between academic disciplines or are in otherwise difficult position. Differing from the old stereotype, the research projects have been rather product oriented and they have created technology demonstrations and pilots and have fleshed out business cases for exploitation of the results. As it can be expected the projects create knowledge in the abstract and academic publications, theses and dissertations, but also increasingly registered inventions, patents and other intellectual properties. While typically applied research projects continue into further RDI, they have attracted incumbents to new areas and also contributed to spin-offs and start-up activity.

TABLE 9. Additionality of Tekes funding for research organisations as viewed by the case study subjects.

	Research organisations
Input and process additionality	Tekes funding has been crucial for **initiating research on particular areas**, typically where the idea is difficult to position academically and there is not a defined industry or business area yet.
(Anticipated) project outcomes	Exploration of new technology, pre-commercial development and demonstration of new products and services, as well as business areas/cases.
Output additionality	The projects have generated new knowledge that is valuable both academically and commercially. Several patents and invention disclosures among other IPR have been created besides new exploitable technologies and demonstrations. At most the **projects have multiplied the number of enterprises working on a particular technology and business area.** The projects have generated also further research and development both commercially and academically.
Systemic impact	The funding for research organisations has created **new research programmes and platforms** and generated fundamentally new knowledge and **potential business areas**. New partnerships have been created that continue after the projects. The projects have also created dialogue between regulators, industry, researchers and consumers that has facilitated systemic changes in attitudes and regulation that enables new business opportunities.

The research organisations' projects have also had significant systemic effects in that they have highlighted entirely new potential business areas and created new research programmes and platforms. The research projects also have offered a platform for dialogue between industry, researchers, policy makers and regulators and users or consumers that facilitate creating changes in attitudes and systemic changes.

CASE **DIVA – DIGITAL SPARE PARTS**

Digital Spare Parts (DIVA, Digitaaliset varaosat) is a novel concept, where the spare parts and the related manufacturing data are stored and transferred in digital form. The spare parts are manufatures with rapid prototyping/manufacturing technologies, such as additive manufacturing, colloquially known as 3D printing, usually close to the end user's premises. The digitalisation of spare parts aims for a better, more flexible and responsive availability of spare parts, and lower storage, manufacturing and transport costs. The quicker delivery of spare parts can also reduce downtime, which can mean significant cost savings. The DIVA project was built to pilot and demonstrate the application of rapid manufacturing in replacing or augmenting spare parts inventory by digital storage.

The project idea was brought forth by a series of workshops held by the main research partners Aalto University and VTT for industrial stakeholders. The consortium included Aalto, VTT and 14 industrial partners including machinery and manufacturing companies, as well as specialists in additive manufacturing. The significance of digital spare parts is that spare parts for legacy machinery are a great expense, as in physical storage of the stock creates expenses and the parts tie capital with little turnover to enterprises. Traditionally spare parts are manufactured based on estimates of needs at the same time as the original product components, or for example when there is free capacity on the production line. The risk is either that there is excess stock of parts, or a shortage, which in turn results in added expense either in the form of inventory and storage or additional set-up cost for hastened manufacturing. ***The DIVA project was set up to explore the potential of digital storage and additive manufacturing of spare parts in Finnish industry and to demonstrate the possible uses in selected cases.***

The project was initiated at an opportune time, as digital spare parts is an emerging concept and the requisite technologies are evolving towards a mature stage at the time, but there are relatively few manufacturing companies and service providers who apply the concept in large scale.

The main outcomes include 8 reported publications in the final report, 12 conference papers and 20 other articles and appearance. The concrete outputs include a software tool for evaluating spare parts for digitalisation that aids in cost/benefit analysis for digitalisation and demonstration of various techniques for different applications, including "smart spares" with added functionalities, lighter optimized structures.

The project has additionally ***contributed to formation of new business around rapid prototyping and additive manufacturing.*** The incumbent original equipment manufacturers have also recognized the possibilities and continue to follow the developments in the area, and some have continued the development of the ideas internally.

Tekes funding has enabled a time exploration of the topic of digitalized spare parts, an area that is about to enter mainstream. ***The project has raised awareness of the possibilities and contributed to formation of business around additive manufacturing capabilities.*** The area has possible great significance for competitiveness

▶▶

and value creation in the future as a part of the service portfolio of Finnish manufacturing industries.

The other experiences and lessons reflect on the different between Strategic Research Openings and latter Co-Creation. ***Typical project cycle is that the exploration of the problem and solutions and building relationship and commitment with the partnering enterprises takes time and it is not easy to hurry along, thus the 5 year cycle is more optimal especially for new actor combinations than approximately 2 years for the more recent instruments***, as in 5 year cycle enables development and demonstration and piloting solution in more realistic and demanding settings than a relatively quick cycle of demonstration. Another change is that when enterprise partners have their own parallel projects, it has the effect of enforcing deeper collaboration, but also lowers the technological ambition level and risk taking compared to SRO-type projects.

Sources

Salmi et al. 2018 Digitaaliset varaosat, Aalto-yliopiston ja Teknologian tutkimuskeskus VTT Oy:n yhteisjulkaisu
http://urn.fi/URN:ISBN:978-952-60-3746-2

4.3 SHOK PROGRAMMES – strategic cooperation and co-creation platforms for RDI

This section presents findings as they pertain specifically to the participants to SHOK-programme projects. The respondents' group was very heterogenous and the individual responses conform to the main groups: enterprises, research organisations and others. Thus, this section highlights the main differences to the answers analysed above.

Specifically, for the beneficiaries of the SHOK programmes, the objectives for participation were generally similar to the previously analysed figures, however in terms of outcome, collaboration especially with domestic partners and related outcomes were more pronounced. This conforms very much to the programme goals and similar findings arise in the case studies.

In more detailed questions, lasting networks are the most pronounced outcome or impact, followed by technology transfer within the same industry and to the public sector, and strengthening of domestic subcontractors. As discussed, these outcomes align with the goals of the SHOK programme well.

When asking if the project lived up to what was expected, a large majority 85 percent answered yes to a large or very large extent. For the question regarding whether the benefit derived from the participation exceeded the cost, 92 percent chose to answer that the cost corresponded to the benefit or that the benefit exceeded the cost, and for 50 percent of the respondents

FIGURE 24. What would have happened if the project had not been funded by Tekes?

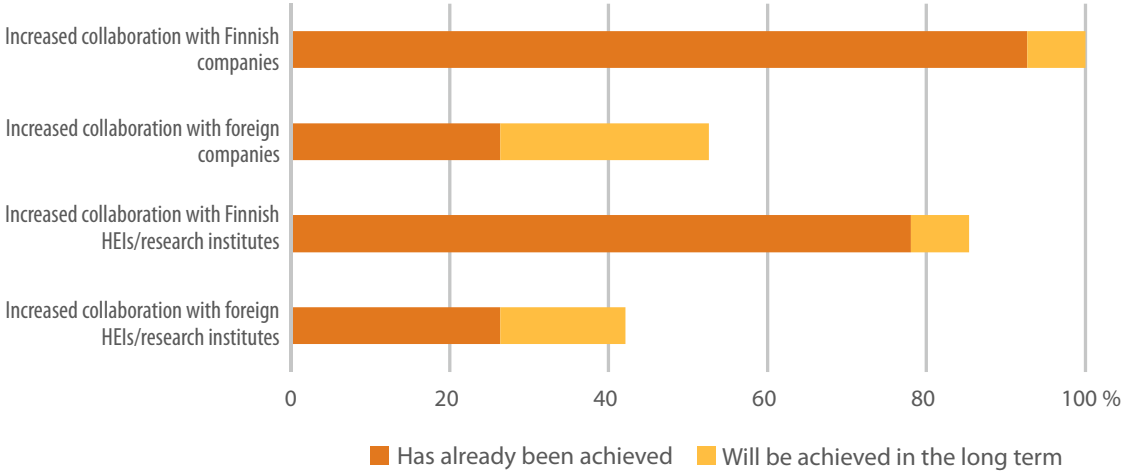
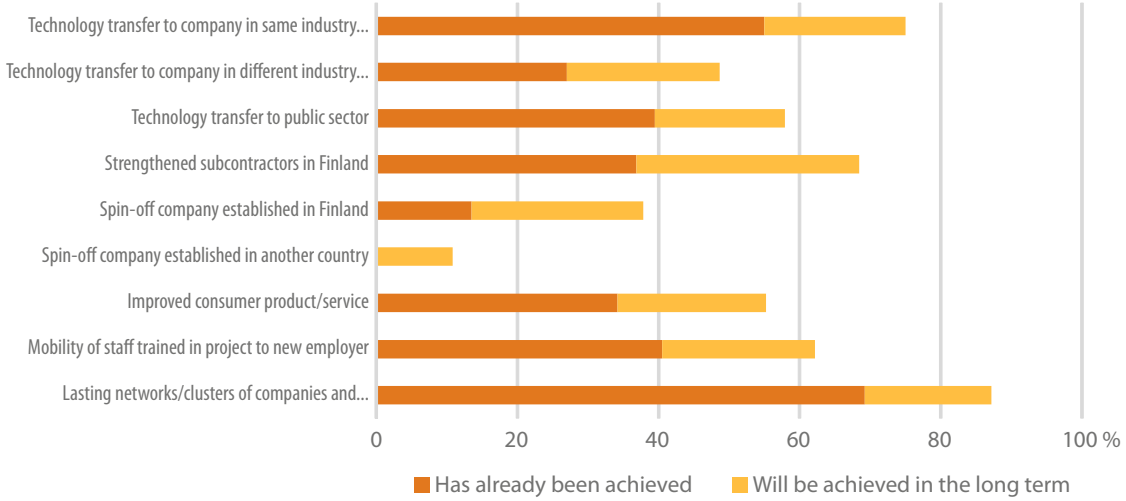


FIGURE 25. What kind of impact the project has had/will have for society?



the benefit was greater than the cost. This is somewhat lower than the other groups, which raises a question whether the SHOKs or the programmes as such provided added value for the partners. This theme was also probed in the interviews connected to the case studies.

The response to the question regarding the reduction in funding is depicted in the picture below. As can be seen most frequent are the alternatives "reduction of RDI projects", "reduction of industrially relevant RDI projects", and "smaller projects and reduced collaboration with Finnish enterprises". Finally, only 3 percent of the respondents in the SHOK group answered that the reduction in national public funding had no effect at all.

To sum up the answers from the SHOK beneficiaries group, the projects have created strong collaboration (mostly at a national level) and intensified technology transfer between the actors. The projects seem to have reached the expected result or exceeded the expectations. They can also be seen as cost effective for the participants. The answers also indicate a strongly that reduction in public funding is also resulting in reduction in RDI projects in general and industrially relevant RDI projects in particular.

Based on the interviews, the SHOK programmes have had similar contribution as the other activities aimed for the Big Three, with an emphasis on the more systemic effects. One of the key contributions that raises from the interviews is that SHOKs have contributed to creating networks and partnerships, but also have pro-

vided a platform and a mechanism to negotiate a joint view of future technology and its business uses. This has enabled SHOK collaboration to contribute to wider technology platforms and standardisation in key areas, e.g. IT and C and stabilised these new areas into established business. A less tangible but significant contribution is also that a generation of present-day researchers and managers have grown into a culture of collaborative RDI and developed their networks with contribution from the SHOK programmes.

TABLE 10. Additionality of Tekes funding for SHOKs as viewed by the case study subjects.

	SHOKs
Input and process additionality	The formation of SHOKs and the funding enabled **reinforcing existing and formation of entirely new networks** between actors in a given area. The process for creating strategic research agendas has been important in creating a **joint understanding of the future** of technology and business in the given areas.
(Anticipated) project outcomes	Development of **technology areas/platforms**, contribution towards standardisation. Technology and product/service development within and parallel to the programmes.
Output additionality	**Significant contribution to standardisation and development of larger technology areas.** Individual projects and sub-programmes have similar additionality as those of others.
Systemic impact	The fundamental systemic effect is that **one generation of researchers and managers have grown in a networked environment**. The projects have also contributed fundamentally to stabilising technology and business areas through joint understanding of the areas of technology and business and associated challenges.

CASE REBUS – TOWARDS RELATIONAL BUSINESS PRACTICES

Towards Relational Business Practices – DIMECC REBUS (2014–2017) programme approached business problems from a systemic perspective, focusing on challenging enterprises to rethink their management practices and business decision making by looking through the lens of business ecosystems to identify and develop practices for managing partnerships and networks in the modern environment.

REBUS focused on particularly transport/logistics and energy sectors, and it especially targeted on networks for project business, logistics, R&D and value creation.

The REBUS programme has its roots in part in the Innovation and Network (I&N) programme (2009–2013), the first FIMECC/DIMECC programme. I&N sought to bring researchers and enterprises together to create what nowadays would be called an ecosystem. Part of I&N was also to create the practices and processes for a collaborative platform that enables effective R&D projects.

The basic idea and lessons from the first programme carried over to REBUS, and the overarching theme was development of business practices for a networked business world, based on building relationships between the public and private entities within the ecosystem. In other words, ***REBUS was not a technology development programme, but rather a management and organisation development programme that utilised technology to solve relevant management problems.***

The programme created a wealth of outcomes: The academic results include 155 publications, 8 doctoral and 14 other theses. To a large extent, the project results are condensed into a jointly written book "Practices for network management - In search of collaborative advantage" (published: 2018, Palgrave Macmillan). Besides the book, the REBUS Final Report presents a cross section of the results and outcomes from enterprise partners perspective.

The common theme over the results is, consistent with the aim of the programme, creation of insights and new management practices through challenging existing management practices and introduction of new tools either conceptual, digital or both. In some cases, the reported outcome or impact is upwards of 100 MEUR of new business/revenue. ***The programme has also given rise to novel ideas that are being developed,*** one of the most publicized might be the "Uber of the Seas" that entails ***multiple changes in transport and shipping value chain and the way shipping business is organized.***

The DIMECC and by extension Tekes contribution has been to create a platform for the stakeholders to bring their existing knowledge and relevant business cases to collaborative development.

The lessons as proposed by the interviews are that, at the programme level, ***an active expert coordinator is one of the keystones in adding value.*** An expert coordinator can coach and challenge individual sub-projects and draw the themes together and facilitate exchange and point out common ground for collaboration between the partners that would not otherwise necessarily meet. ▶▶

Another lesson is that careful preparation and partnering create added value in the process. For example, in one stream of R&D under REBUS, the partners had already explored the business area in detail and had compiled a roadmap for R&D to be implemented before the programme started. This provided a base to build on early in the programme, and it has also enabled continuing the collaboration after the programme.

Sources

DIMECC, 2017, REBUS – Towards Relational Business Practices: Final Report, DIMECC Publications No. 14

FIMECC, 2014, Innovations & Network: Final Report, FIMECC Publications No. 1

4.4 SYSTEMIC IMPACT OF BIG THREE FUNDING

To summarise and compare, according to the survey, the most common impacts for the projects are improved RDI capability, new specialty and pilot or demonstration. The latter is the most uniform impact across the groups, roughly two out of three projects have created or will create a pilot or demonstration. This reinforces the product or service orientation of the RDI projects, which is, of course, in line with the intentions of funding.

As can be seen from the answers regarding different objectives, the possibility for collaboration is an important objective for most of the respondents. We also included a question regarding why an organisation was interested in collaboration. The following figure (Figure 27) illustrates that the interest in to onset to a large degree is technical in the beginning. However, as discussed above, the horizon might broaden during the projects to include development practices and other forms of behavioural additionality.

A large majority of the respondents agreed that the results and impacts of the project lived up to the organisations expectations. More than 80 percent of the HEIs and research institutes and more than 70 percent of the enterprise group agreed on this. For this question we also looked into the differences between large companies and SMEs. The differences showed to be only a few percent thus both large enterprises and SMEs seems to have a rather equal opinion regarding the expectations of a their Tekes projects. Also, a vast majority of the respondents saw that either the benefit exceeded the cost or that the benefit corresponded to the cost. Only a few respondents chose the answer “The benefit did not correspond to the cost”. The numbers for this option being 5 percent for HEIs, 3 percent for research institutes and 12 percent for enterprises.

FIGURE 26. To what extent were the following objectives important for your organisation to participate in the project?

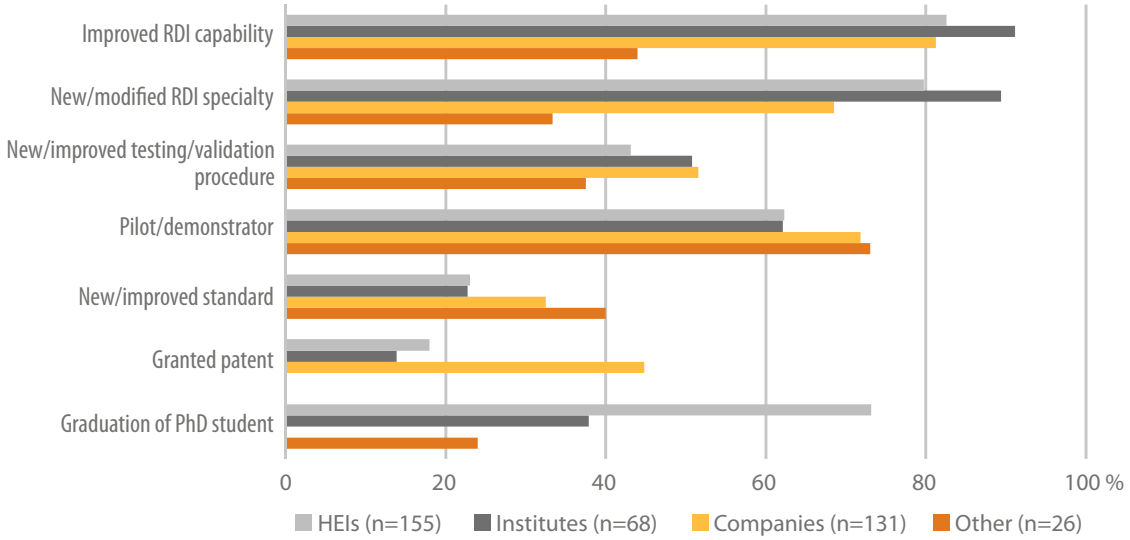


FIGURE 27. Why did you choose a collaborative research project?

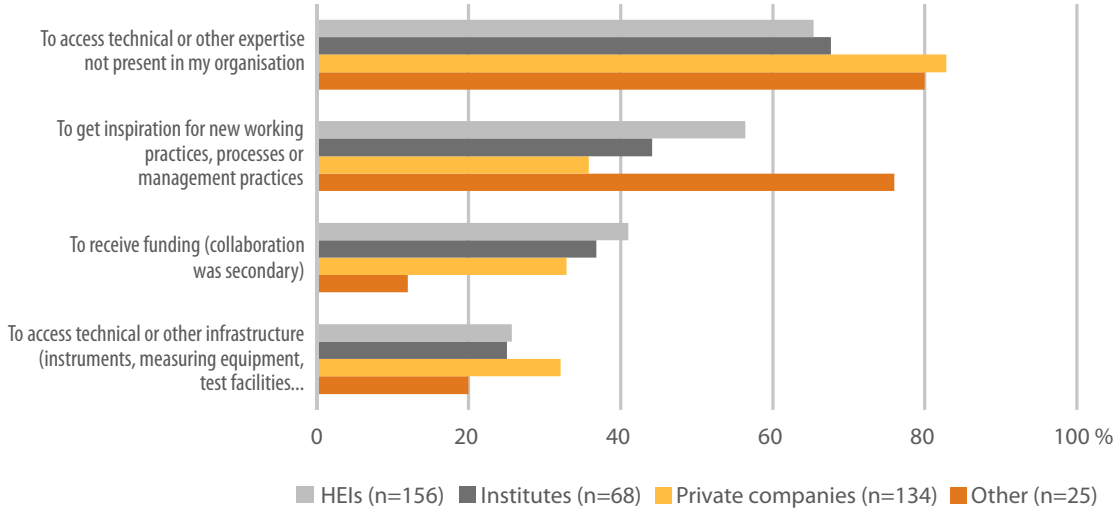


FIGURE 28. Please assess what would have happened if the project had not been funded by Tekes?

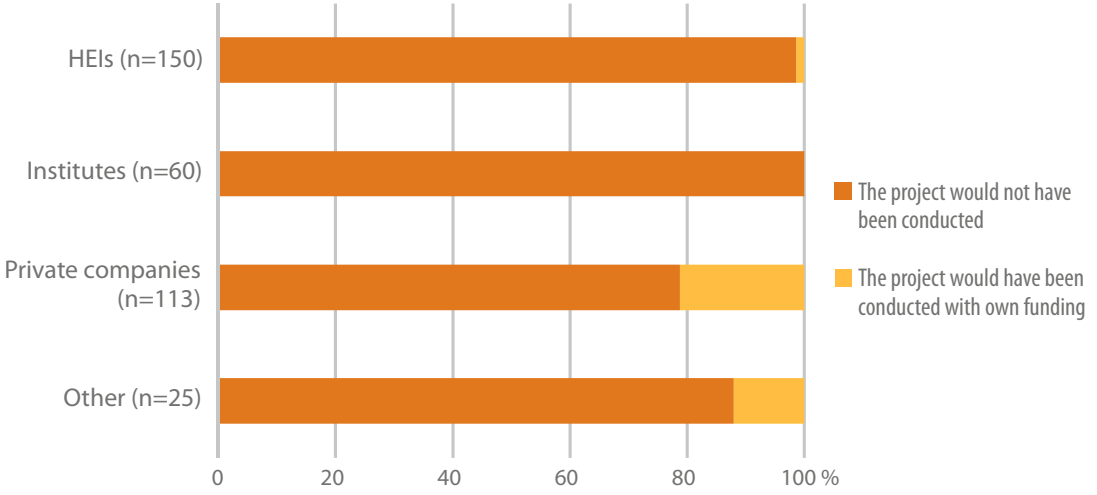
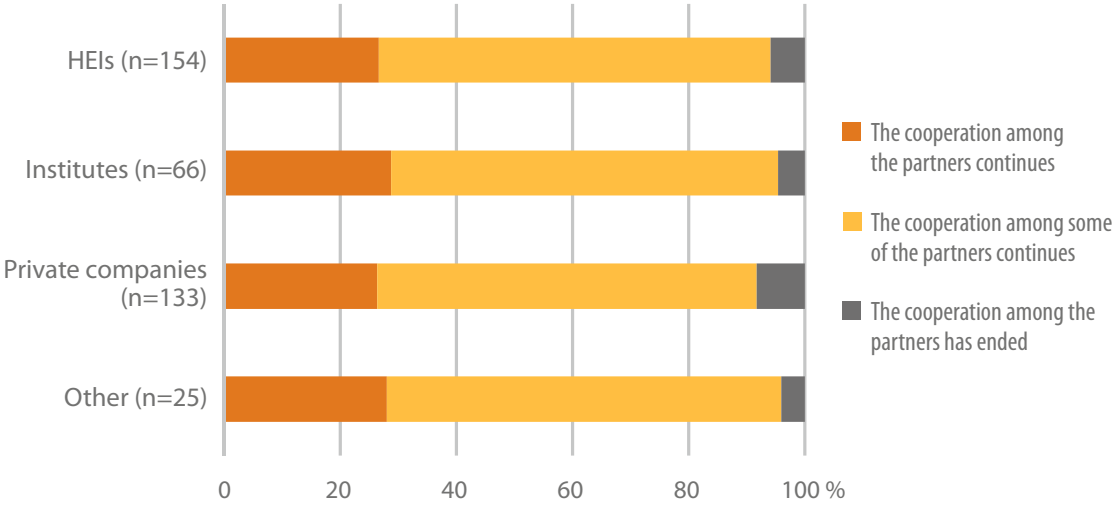


FIGURE 29. What has happened with the project consortium/partnership after the end of the project?



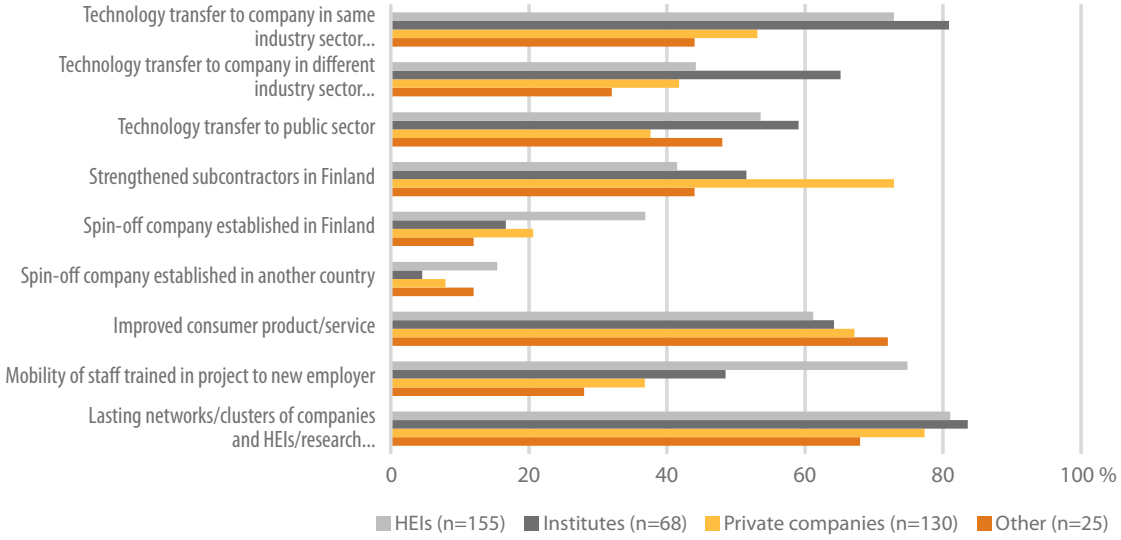
As a "standard measure" of additionality, the respondents were also asked would the work have been conducted without Tekes funding. Only 21 percent or the enterprises and 12 percent of the others responded that the project would have been executed without the funding. Only a few research organisations would have been able to go through with the work without the funding.

In terms of collaboration, almost all of the beneficiaries have also continued collaboration with at least some of the partners after the initial project. This also reinforces the finding that creating stable partnerships or networks is one of the key forms of behavioural additionality of Tekes funding. The data do not distinguish whether continued collaboration was privately or publicly funded though.

Regarding the societal benefits or externalities, the most common findings across the board are lasting networks, technology transfer and new and improved products and services. For the group HEIs also "Mobility of staff trained in project to new employer", "Technology transfer to enterprise in same industry sector (as enterprise/-ies that participated in the project)" and "Improved consumer product/service" were frequently chosen alternatives, with 75 percent for the first alternative, 73 percent for the second and 61 percent for the third. A similar pattern is observed for research institutes for the alternative "Technology transfer to enterprise in same industry sector" (80 percent). The third and fourth most common indicted impact for research institutes were "Improved consumer product/service" (64 percent) and "technology transfer to public sector" (59 percent) respectively.

The picture is somewhat different when turning to the answers from the enterprises. Again "Technology transfer to enterprise in same industry sector (as enterprise/-ies that participated in the project)" and "Improved consumer product/service" were frequently chosen alternatives with 67 percent for the second alternative and 53 percent for the first. For the enterprises the second most frequently chosen impact for the society was "Strengthen subcontractors in Finland" as many as 73 percent of the respondents from the enterprise group indicated this as a societal impact resulting from the project. This is in line with previous presented results about increased collaborations with other enterprises in Finland.

FIGURE 30. What kind of impact the project has had/will have for society?



To condense, the results suggest that the ***projects contribute to building networks and ecosystems***, as collaboration has been both an important goal for many, and even more commonly an outcome of the project, and the collaborations are stable after the projects. The outcomes prominently include strengthening collaboration, building up particularly subcontractors and knowledge transfer to other enterprises. Further, the orientation of research institutions and HEIs has been towards collaboration with enterprises and in half of the cases towards piloting and demonstrations. ***Overall Tekes funding has a clear additionality at the system level as a majority of enterprises and almost all researchers view that the projects would not have been completed without the granted funding.*** The finding that most respondents report that the lowering of Tekes budget and associated changes in funding have negatively affected R&D volume and ability to conduct R&D also reinforces the finding related to additionality.

4.5 LESSONS FROM CASE STUDIES AND INTERVIEWS

The findings from the survey are reinforced by the interviews. The respondents also provide more nuanced view to the additionality of funding. Starting from input additionality, at the *enterprise level* risk sharing enables developing more uncertain and 'really new' projects[37], and enables investing more in them, which means broader and in-depth development. Also, at the ecosystem level, the projects have created new partnerships and stable network connections and facilitated collaborations. Further, the projects have created joint understanding of technology and reinforced user orientation and understanding of end-user needs. At the level of *knowledge*, the projects have created knowledge about technology and markets, IPR, and demonstrations both reinforcing existing business and technology areas and highlighting entirely new areas. ***In sum, input additionality seems the clearest when funding is directed to really new or radical areas of technology and markets, and when the projects are relatively large and long-running.***

The output additionality of Tekes funding is also varied. The funding provides *leverage,* as the projects have been completed with more scale and depth and with more quality than would have been possible without the funding. At their most tangible, the projects have contributed to creating *business, products and services:* the projects have contributed to technology development and products and increasingly services based on the technology. The projects have also attracted business and contributed to start-up activity in various business and technology areas. Finally, the sponsored RDI also creates *knowledge,* including IPR and pre-commercial demonstrations. They have also highlighted new areas of business and technology for commercial exploitation. In these aspects ***the output additionality is also the clearest when the projects have focused on really or radically new business and technology areas***.

> ***The clearest case for Tekes added value is found in large, long-standing and really new or radical projects.***

The systemic effects have been already discussed to extent, but to summarise Tekes funding has contributed to first of all *partnerships,* as they have broadened networks, introduced new partners to each other, and contributed to stable partnerships and networks beyond project duration. In a more subtle but important way the funding has contributed to creating a *culture and behavioural additionality*. The projects have contributed to renewal of ideas and practices in various organisations. At its most fundamental the projects have raised a new generation of researchers and managers into a new networked operating model. Another dimension of behavioural additionality is that particularly the large long-running projects

[37] A really new innovation is one that is new for the enterprise developing and introducing it or for the market buying, as distinct from radical innovation that do not have an existing market nor an incumbent value network, e.g. Garcia and Calantone 2002.

TABLE 11. Summary of case studies.

Project	Project Leader / Key Partner	Focus Sectors	Main impact	Tekes' Main Contribution
5G	Nokia	Telecom	Ecosystem building	Longitudinal commitment in the area
Data to Intelligence (D2I)	DIGILE / DIMECC	7 different sectors	Capacity building	Funding
Digital Spare parts	Aalto and VTT	Manufacturing	Creation of new business opportunities	Funding
Design Driven Value Chains in the World of Cellulose (DWoC)	Aalto and VTT	Paper and pulp	Creation of new business area	Enabling new combination of actors and new kind of project
Insects in Food Chain	University of Turku and LUKE	Food	Creation of new business and research area, and ecosystem	Enabling new combination of actors and new research area
Internet of Things (IoT)	TIVIT / DIGILE	Telecom	Ecosystem building, increased interest towards IoT as RDI area	Funding
Kesko Dream Builder	Kesko	Retail	Creation of new business concept	Expertise and sparring
Towards Relational Business Networks (ReBus)	FIMECC / DIMECC	Logistics and Energy	New business ideas, restructuring of value chains	Funding
Valmet DNA	Valmet	Machine building	Securing global competitiveness	Enabling building partner network

of the past have contributed to creation of *dialogue and common vision:* ***The projects have created dialogue between regulators, industry, researchers and end users to create mutual understanding of challenges and opportunities in given business areas.*** The case "insects in the Food Chain" presented below gives an example of importance of creating an open discussion between ecosystem players. The projects have also contributed fundamentally to stabilising technology and business areas through joint understanding of the areas of technology and business and associated challenges. Also, in these aspects the additionality is largest in larger, long-standing and really new or radical projects.

The previous discussion stressed how the additionality or leverage of Tekes funding is the clearest in larger, longer running and trailblazing projects. These projects have, according to the interviews, more apparent and broader benefits for ecosystem building, networking and collaboration together with developing really new solutions and opening or addressing new markets. However, the more "traditional" RDI projects do add value to R&D and help renew organisations and their processes and practices too, and in that they are also effective for addressing specific technological problems or RDI needs like development of a specific product-service combination. Looking at the interviewees' responses to the different funding services or instruments, qualitatively the systemic and ecosystem building effect tend to be larger in larger projects. The large programmes are also an opportunity to invest in standards development and other major efforts not otherwise feasible.

CASE **INSECTS IN THE FOOD CHAIN**

The Insects in the Food Chain project (2015–2017) aimed to enable the growth of insect economy in Finland. The research by University of Turku (UTU) predicted the changes in consumer attitudes towards the insect foods, global legislation and potential for the food industry. Natural Resources Institute Finland (Luke) explored the various industrial scale side streams as insect feed, as well as performed trials on insect ingredient as part of feeds for poultry and fish.

The Insects in the Food Chain project was funded by Tekes's Green Growth programme, and it had total volume of 335 000 euro. UTU acted as project leader and Luke as research partner. There were several companies, both big and small, involved in the project.

Insects provide a promising new resource for the whole food chain including applications in human food and animal feeds. Though insect economy offers a potential sustainable solution for many challenges in the food production, work is needed to fully utilize this potential. The challenges that field was facing in the beginning of the project included, for example, consumer acceptance, placing insects in food regulatory system and reaching the level of continuous development.

Despite of the huge potential of insects in the food chain, the research in the area is scarce, and research discipline is only emerging. The aim of the project was to produce new know-how through cooperation between companies and researchers and raise Finland in the forefront of a new kind of international insect bioeconomy. The project was the first extensive project to tackle with the challenges of insect economy in Finland. The research area was developing rapidly, and the project aimed at creating relationships with key international researchers.

The aim of the project was to find out the best conditions for the production and utilisation of insects as a source of food or raw material in various parts of the food chain, from insect growing to consumers. The project combined the food, fish and poultry economy as well as the natural science research to the law and consumer research in an exceptional way. An important part of the research was to anticipate changes in legislation as well as consumers' attitude towards insect food.

The project practically ***opened a new research area In Finland.*** This was the first time when a research project related to insects as food got public funding in Finland. Also, this time getting the funding was not easy as the decision in Tekes was not unanimous and almost half of the decision makers did not support the funding for the project. As the project was the first one in the field, it created ground for the other projects. Changes in the attitudes of R&D&I funding instances were remarkable during the project and partly due the project. Project generated numerous other projects which were funded for example by Academy of Finland and Ministry of Agriculture and Forestry. The project also contributed remarkably to the ***growth of the research area inside Luke***. Today it forms a central part of one of the strategic areas of Luke (healthy and profitable food production), and Luke has also invested itself to the area. For example, Luke opened a new InsectLab which offers a wide range of solutions for the industry, including, for example, farming insects, product development, breeding material management and development, utilizing side streams as well as developing holistic sustainability of the industry. Today the research area is well structured inside Luke.

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The project also ***gave path the birth of new research areas***, especially in Luke. For example, in the project it was noticed that as the food chain is difficult and demanding, insects could be used as disintegrants of harmful biological waste outside the food chain for the purposes of producing biogas or biodiesel. The project gave useful understanding related to the by-product preferences which are important in this respect. As a concrete result Luke is having two R&D projects with waste management companies for the utilisation of insects in their processes.

The project ended last year, and some of the ***scientific articles*** has not been published yet. At the moment, altogether 4 scientific papers have been published, and project has contributed to one doctoral dissertation.

In 2015 when project started the number of companies operating directly in the insect business was 5, today it is around 50. The huge change in numbers, and ***building of a new business ecosystem***, can be indirectly traced to the project. The project can be regarded as the main contributor for the change in the way Finnish authorities interpret the EU insect ***legislation***, and Finland become one of the first countries in EU which allowed insects to be used as human food. This, of course, was a crucial step for the commercial usage of insects. Another crucial step was taken when authorities started to treat insects as animal feed the same way as fish. This was also to large extent a contribution generated by the project.

All in all, due to these changes in legislation ***Finland is at the moment a clear forerunner in the field, both when it comes to R&D&I and commercial utilisation of insects.*** It can be argued that at time when project started a window of opportunity of open and the project helped to open that window. Project also brought about ***attitudinal changes*** among legislators, authorities and consumers. Project facilitated an open discussion between researchers and both legislators and authorities. An example of that is a legislation workshop which Luke arranged together with Ministry of Agriculture and Forestry and Evira. The open discussion has continued, and today the discussion concerns the usage of insect protein in human food and practices in insect farming.

Being a new research area, project also had a task to build the ***international networks.*** As a result, Finland became an active member of NICE – Nordic Network on Insects in Circular Economy, and created relationships and research collaboration with e.g. TNO and Wageningen University in Netherlands. The insect companies involved utilized the project results for acquisition of funding from both public funding bodies like Business Finland together with private investors. The project results and the changes in legislation gave them a ***proof for commercial potential***.

It can be argued that the ***project funding form Tekes was crucial for the development of both research area and business sector in Finland***. Without the project it is likely that both the research sector and consumers would wake up to the importance of the area after the publication of IPCC report. The researchers might also follow the discussion started by researchers in other countries, and be followers, not leaders as they are now. The business sector would consist of less than 10 companies (now approx. 50), and business would not have great growth potential as it has now. The important lesson this case has to offer for Business Finland is that it is valuable to invest in new openings which do not have at the particular point of time huge market potential, for example, due to legislative restrictions, as these projects can turn out to be change agents, which change the operating logic of the whole value chain.

One question that was probed in the analysis was the perception of strengths and weaknesses between the funding services offered for the large enterprises and research organisations. Generally, the interviewees were satisfied with the Tekes services across the board, but analysing the statements as collated in the following table, some points of strength and weakness emerged. While we have discussed that the Tekes added value is largest in substantial and far-reaching projects, the data also suggest that there is a marginal benefit to growing the volume of funding and the size of consortium.

The data do not give an analytical answer as to the optimum size of project volume or consortium size, but as in the one ned of the spectrum "traditional Tekes projects" are somewhat criticized for short duration and narrow scope and in the other end the SHOK project participants noted freeridership and internal fragmentation, it seems that the Strategic Research Openings may be a good template with up to 5 years runtime and 10-million-euro volume and typically a tight consortium of less than ten partners. When the number of partners per project/programme approaches or surpasses 20, the reports of internal fragmentation and freeriding seem to increase, or as pointed out by one interviewee that simply 'bringing enough people in the same room and giving them money is not a guarantee that significant new insights arise from the collaboration'. The other good practices highlighted based on experiences from the SHOKs were consortia selection based on common interest and vision of technology and markets. In terms of programme management, the best practice was involved programme coordination and coaching by an expert in the field.

Going deeper into the ramifications of consortium structure, the cases paint a contradicting picture to some extent. It seems that **from the standpoint of short to medium-term "Horizon 1-2" impact, it is essential to include committed enterprises** with real problems to be solved, which seems to encourage relevance of the RDI activities and also early adoption of results to business use. However, the problems to be solved need to be common or generic enough to provide a marketable reference. Then on the other hand from the perspective of creating really new and boundary crossing openings that create really new innovations and future capability past the immediate business needs, "Horizon 3" development, commitment of enterprises can actually have a negative impact, as the enterprises tend to draw the attention to more incremental development and also according to the interview, sometimes lower the technological ambition and risk taking in the project. Thus, **programming seems a balancing act between incremental development and leveraging existing capabilities and business models, vs. developing new capabilities**. This balance is perhaps best solved at the portfolio level, ***having separate instruments for incremental and really new innovations***.

Regarding the instruments or services, generically the selection didn't attract criticism and the portfolio is sufficient, except the only gap seems to be infrastructure for pilots and demonstrations. One such example is the 5G Test Network Finland, that

TABLE 12. Comparison of the strengths and weaknesses of the services/instruments as viewed by the interviewees.

Instruments	Strengths	Weaknesses
Tekes Programmes / RDI projects	A good fit for solving specific, relevant technical/technological problems and developing solutions Effective means for fulfilling relatively small and narrowed-down industrial R&D needs	Small size and short duration enable focusing effectively only on relatively minor/incremental development
Strategic Research Openings, Networked Research	Longer duration and larger volume of projects enables exploration of a technology area and developing really new solutions, in a manner not possible with 'ordinary' Tekes RDI projects and without the added bulk of massive consortia	Path to commercialisation can be unclear IPRs, specifically appropriability of knowledge can be an issue
Co-Creation/ Co-Innovation	"Scaled down strategic openings" – basically the same advantages as above in Strategic Research Openings	Co-Creation phase is basically seen as funding to enable writing the application for Co-Innovation Relatively small and short duration (compared to SHOKs and SROs) hinders development of fundamental advances The structure adds administrative overhead and waste, as multiple projects and proposals are needed to be synchronised to achieve the same as Strategic Openings Synchronisation of the time-window for stakeholder needs and interest is very challenging and hinders development of project consortia The structure of parallel projects may reinforce or intensify collaboration between researchers and enterprises, but also tends to push development towards less technological risk ambition and towards more incremental projects
SHOKs	Created a platform for collaboration for e.g. standardisation Enabled creating platforms and networks and raising a generation of managers and researchers in a new culture of collaboration	Challenges in developing sharp enough focus and keeping all the partners engaged The consortia experienced some freeridership and fragmentation of interests due to the sheer size of the programmes Ownership of results, IPR and appropriability were an issue The trade-off between services rendered by the intermediary and double reporting between the intermediary and funding agency has been questioned

has become an important platform for development and testing, but since it is a common piece of infrastructure any one partner has trouble financing all of such, and if one would, then ownership and results become an issue. The 5G case is presented in more detail below. Whether the funding is from Business Finland or for example form EU Structural and Cohesion funds, there is a need and a gap for Business Finland to offer a mechanism for supporting test and pilot facilities for RDI activities.

Another aspect of the consortium structure is that typically as it seems, the research projects, such as EVET and SRO in the examples, create interesting and really new results in terms of technology and IP but then the problematic part is commercialisation. In the other end of the spectrum, the data suggest that enterprise-led projects are useful for renewal and developing new practices and products or services, but they tend to be more conservative, incremental and reinforce the existing position rather than seek entirely new technology or business areas. In other words, the projects tend have more direct commercial implications, but more likely within the existing realm of technology and markets. In sum, ***the results of large open RDI projects in terms of new technology and IPR are impressive, but the business take-up is slower***. It was observed in the (mid-term) evaluation of SHOKs and similarly in this study that ownership and appropriability of IPR is a challenge in large open networks. It can by hypothesised that from the standpoint of efficiency of commercialisation and commercial impact, ***the optimum setting would be that a (large) enterprise partner, with existing complementary assets and extensive sales networks, spearheads the project and takes care of commercialisation***.

However, the data also suggest that there is any number of reasons that that prevent or hinder incumbents from commercialising really new co-developed innovations. These the not-invented-here -syndrome, the inability to recognise the potential of technology and innovation due to lack in knowledge base to evaluate it, lack of complementary assets including knowledge and tangible resources to exploit the opportunity, and lack of appropriability as in inability to secure the innovation and exploit it without fear of replication and escalation of competition, or plain conservative attitudes, risk avoidance and avoidance of (possible) self-cannibalisation.[38] The question is that how can RDI instruments incentivise incumbents to take up innovation more readily; while the data do not give direct answer, the possibilities include selecting enterprises that are committed to the RDI project throughout the top management, and defining IP ownership to minimise appropriability and ownership problems and offer incentives, "win-win-win", for each type of participant.

Another approach entirely proposed in the interviews would be to adopt some version of the so-called DARPA- or mission-oriented approach, i.e. ***rather than funding development of technology and business in gener-***

[38] This discussion is more fleshed out in e.g. Piirainen et al. 2018 The reverse tragedy of the commons: an exploratory account of incentives for under-exploitation in an open innovation environment, Technology Analysis & Strategic Management, Vol 30, Issue 3.

al, proposing a challenging real-world problem and selecting consortia to solve the problem. Some examples mentioned telemetry installation for the road network and optimisation of traffic infrastructure use in major city regions of Finland or developing IT infrastructure for social services and healthcare. The advantage would be that completing the project would create public goods and give relevant references for the participating enterprises for export markets. At the same time, this would also require a whole-of-government approach to building programmes and securing commitment from the problem owners as much as any other stakeholder.

CASE **5G**

Finland emerged as a world leader in mobile communications in the latter half of the 1990s and early 2000s. Since those times, Finnish enterprises and researchers have been active in pushing the development of mobile communications including handsets and increasingly network infrastructure. Network standards development plays a key role in the infrastructure business and enables new products and services to be marketed for operators and consumers alike.

The latest fifth generation (5G) of mobile network technologies is a family of technologies that together mark increased performance especially for the network side, that enables offering consistent quality of service and high-speed communication in an environment where the number of transmitting devices is increasing exponentially with the mainstream adoption of various 'Internet of Things' or IoT technologies, which create massive arrays of active sensors and other devices that communicate over wireless networks.

The overall objective in 5G development is to provide an enabling technological platform for various other products and services.

Specific outcomes include technologies, business models and contribution to standardisation. Overall Tekes funding for the IoT programme and specific 5G development has enabled the funded networks to collaborate in proposing contributions to 3GPP, IETF and ITU. The technologies developed under the 5th Gear for example include advances in millimeter wave radio technology, that is fundamental in achieving the performance targets set for 5G transmission as well as base station development.

One central outcome in 5G development has been the development of the 5G Test Network Finland (5GTNF), with funding from Tekes/Business Finland 5th Gear programme and European Union, and the associated 5GTFN ecosystem. The test network has enabled development of specific technologies and services and continues to do so. The 5GTNF ecosystem comprises altogether ~50 partners (including network manufacturers, operators, technology and test system providers and research organisations) and large R&D portfolio covering technology and service R&D, testbeds development and vertical trials. 5GTNF created state-of-the-art network infrastructure for 5G technology trials and demonstrations and provides now flexible and

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evolving platform for 5G service development and testing with standardized interfaces for 3rd party equipment and service integration and extensive access to network and user monitoring data

The Tekes funding has also enabled developing new business models and concepts, such as economic and technical feasibility studies for local micro-operator concept, for operating localized 5G networks particularly suited for industrial applications. A related major outcome is the Nokia Bell Labs -led LuxTurrim 5G ecosystem, where altogether 14 research and industry partners spanning 5G technology, instruments, composites and construction are developing 5G network infrastructure based on smart outdoor lighting poles as platform for various smart city applications. Technology and product development continue, for example, Nokia Corporation signed a 500 MEUR loan contract with European Investment Bank and another 250M with Nordic Investment Bank late 2018 specifically for developing 5G technologies.

The role and contribution of Tekes behind 5G cannot be traced to a single activity but rather to consistent and patient investment in the area of IT and telecommunication. Over the years Tekes has funded, coached and challenged the actors, enterprises and researchers to think of new and better solutions. These activities have resulted in long-standing and fruitful development partnerships and trusted relationships.

One of the key contributions of SHOKs and subsequent programme activities has been to offer a platform for the actors in the 5G area to develop network ties and pursue mutual interests that shows in the outcomes. For relatively technology-intense areas such as 5G a key for progress is to ***build a critical mass of lead enterprises and researchers,*** together with other partners, for substantial and long-standing projects. However, in the present climate, one missing part is that there is no instrument that is particularly suitable for funding test or trial infrastructure and similar platforms, and as a related problem that partially stems from the funding is that when test environments are built partially on project funding and partially on partners own funds, the contractual framework tends to get muddled and ownership of the environment and the RDI results becomes an issue. Solving these issues becomes ever more important in future programmes where the need for common data infrastructure and development environments/platforms becomes more pronounced.

The root of the added value in programme activities is that Tekes programme managers know the industry and technology well, and they are familiar with the overall roadmap and thus they can provide expert advice and mentoring especially for newer entrants and can challenge established incumbents. The existing relationship between the stakeholders also facilitates building programmes in collaboration with the stakeholders based on recognized RDI needs. Another key in general is the consistent and long-standing investment in the area in general and infrastructure, that have enabled growing an ecosystem of actors that creates added value for all parties. More specifically in the latter stages, the 5th Gear programme was implemented exactly in the right time, when the local ecosystem was ready and able to reap the benefit from the development, but at the same time earlier than major European competitors, which has given Finnish actors lead in developing 5G technology and solutions.

Similar contradiction is found on the relation to the services offered by funding agency or intermediary organisations. Across the cases various interviewees have been critical of the added value created by the funding agencies and intermediary organisations, typically these would be seasoned RDI actors with well-developed existing networks across research and industry. However, at the same time most recognise that especially far reaching RDI needs to be based on solid understanding of the dynamics of the technology area and business. The common denominator is that ***RDI efforts need insight to industry and technology dynamics, but the question is who should frame the substance of the programmes and who should facilitate it***. This partially relates to experiences from large programmes, where ***the best experiences seem to come from projects where the core consortium had already conducted a pre-study and exhaustive exploration of the problem space before the funded project***.

Overall lessons for ecosystem policies

1. Ownership of the programme at both policy and substance level need to be clear and stable – Transformative and systemic innovation needs driving and champions and growth of ecosystems takes time, stable framework and continued securing of commitment are needed
2. There are declining marginal benefits for adding members to R&D consortia and with more participants come more fragmentation and freeloading – Cohesive and committed participants, limited consortia, selection needs to be based on a track record of delivering outcomes and a genuine interest and commitment in creating something really new and transformative
3. Tekes/Business Finland added value has been the clearest when initiatives are the kind that typically fall between established industries and research disciplines - substantial, far reaching and really new – Future PPPP initiatives need a focus that is not primarily incremental and preserving existing business models or value chains, but developing new to the participants and possibly the world
4. The role and services of coordinators/programme offices/cluster organisations need to be thought out from the perspective of value added – What services add value and who can provide the service at the best cost/benefit -ratio?
5. Open selection process for ecosystems likely benefits the previous points, as long as the selection criteria are balanced towards creating healthy and committed consortia
6. Monitoring should be built in funding and key indicators should be selected to support policy goals and progress of substance roadmap beside financials – Abstract goals of future turnover are not helpful in monitoring and steering the progress of a research programme

At the more operational level, while Tekes generally is quite customer oriented, the interviewees posed critique towards the funding process, particularly consistency of communication relating to the rules and guidelines, transparency of project evaluation and clarity of the instrument/service portfolio. The challenge stems partially from interaction between the customer contact people and the funding process within the agency, and partially from the funding/decision process. The latter is a challenge especially for Group Projects or Co-Innovation, where apparently the customer representative for each partners' separate adjoined application partake in the decision semi-independently. ***The proposal would be to further streamline the application process by separating the programme and other services more clearly and offering the funding as one distinct product with a clear and transparent process*** both as open application bottom-up funding and for programme participant, assigning one responsible Business Finland representative per project, however many applications are in the consortium, and to simplifying and communicating funding criteria consistently.

Specifically concerning large enterprises, there is also challenges in incentives. As one interviewee exemplified by laying out the problem that when proposing a project for Business Finland, the offer was an RDI loan to cover 40 percent of the project total investment, with the caveat that 40 percent will be sub-contracted from SMEs. The funding conditions proved impossible to accept in group financial administration. It was further asked if there is a strategically important area of competence that needs development, and there are no partners to buy the expertise from, why would it make sense to first teach subcontractors and then buy the expertise from them, instead of developing the capability in house. From another perspective, it was also criticised that the present funding conditions heavily incentivise including SMEs foremost as subcontractors, which puts SMEs in a disadvantaged position even when they have a substantial contribution. These experiences illustrate the questions enterprises have with funding; the underlying message is that ***providing incentives for collaboration is a commendable objective as such, but the funding model has to provide incentive for all parties alike***. Based on the interviews, it is unrealistic to expect any type of participant to collaborate out of altruism, large and small enterprises alike are very typically answerable to their owners and they have to fulfil financial obligations first, whereas researchers are driven by need to publish results and secure future funding and so on.

4.6 IMPACT OF TEKES BUDGET CUTS

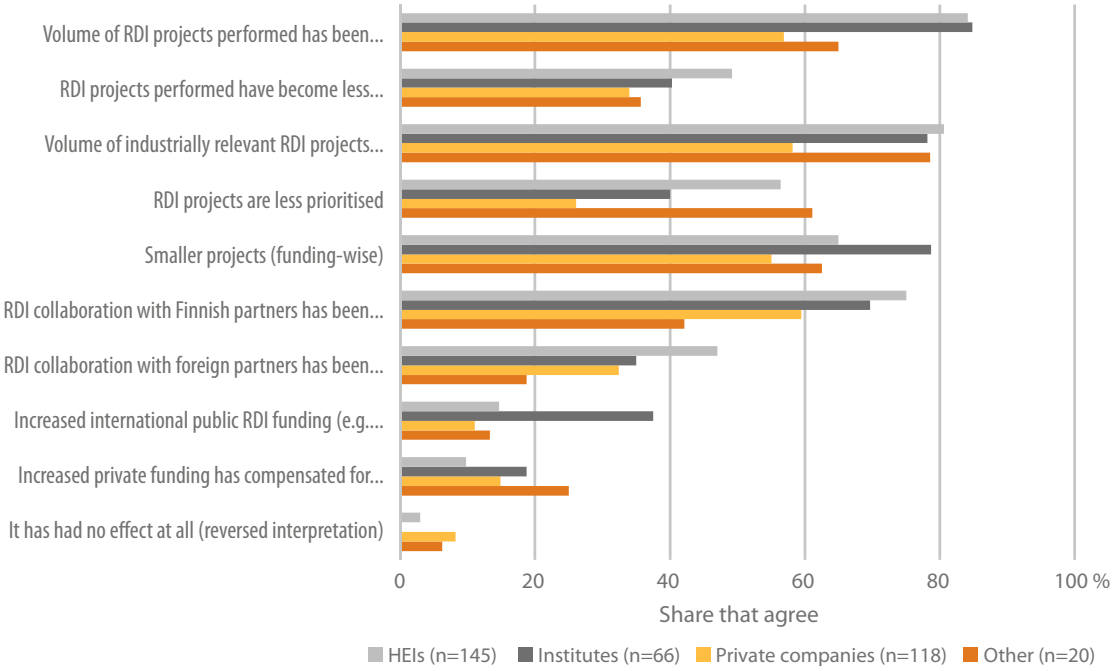
One of the specific questions posed in the evaluation assignment was to probe the effects of the declining budget appropriation to RDI funding. As discussed above, the main changes in the applied research and RDI sphere are that Tekes granted funding has consistently lowered during the terms of the last two governments after the all-time high in 2010 to the present level. Si-

multaneously the share of funding to large enterprises out of total funding for enterprises has decreased. Additionally, the SHOK programme was phased out between 2015 and 2017. The respondents were asked to assess what effect the reduction in Finnish public RDI funding has had on their organisation.

The respondents could then choose from ten different statements, including the option "it has had no effect at all". For each statement the respondents were asked to Strongly disagree, Disagree, Neither disagree nor agree, Agree, Strongly agree or Don't know. In the following picture, we have collected the answers to the alternatives Agree and Strongly agree. For the enterprise representatives, approximately half had experienced lower RDI volume in general and especially the volume and the size of industrially relevant RDI projects have been shrinking, and collaboration with domestic partners has been declining as well. The effects for research organisations are similar, only more common. No large differences were observed between large enterprises and SMEs, except that 45 percent of the SME-group agreed or strongly agreed that the RDI collaboration with Finnish partners has been reduced due to the reduction of the public funding, while the corresponding number for the large enterprises was 65 percent. This raises the question are large enterprises actually more dependent on public funding for collaboration or is it a question of attitudes; collaboration being viewed as a luxury that is engaged in when public subsidy is available and not otherwise.

Virtually all respondents reported negative effects on RDI activity due to budget cuts. All of the research institutes and HEIs had experienced these effects, and only 8 percent of the enterprises had not felt any effect. Between a third and half of the respondents also saw RDI projects becoming less competitive due to declining funding. Interestingly only between one-in-six and one-in-five reported that increase in other public or private funding has filled the gap for the declining funding, the exception being HEIs where almost 40 percent reported that increased use of international (e.g. EU funds) has made up for the change.

FIGURE 31. What kind of effect has the reduction in Finnish public RDI funding has had on your organisation?



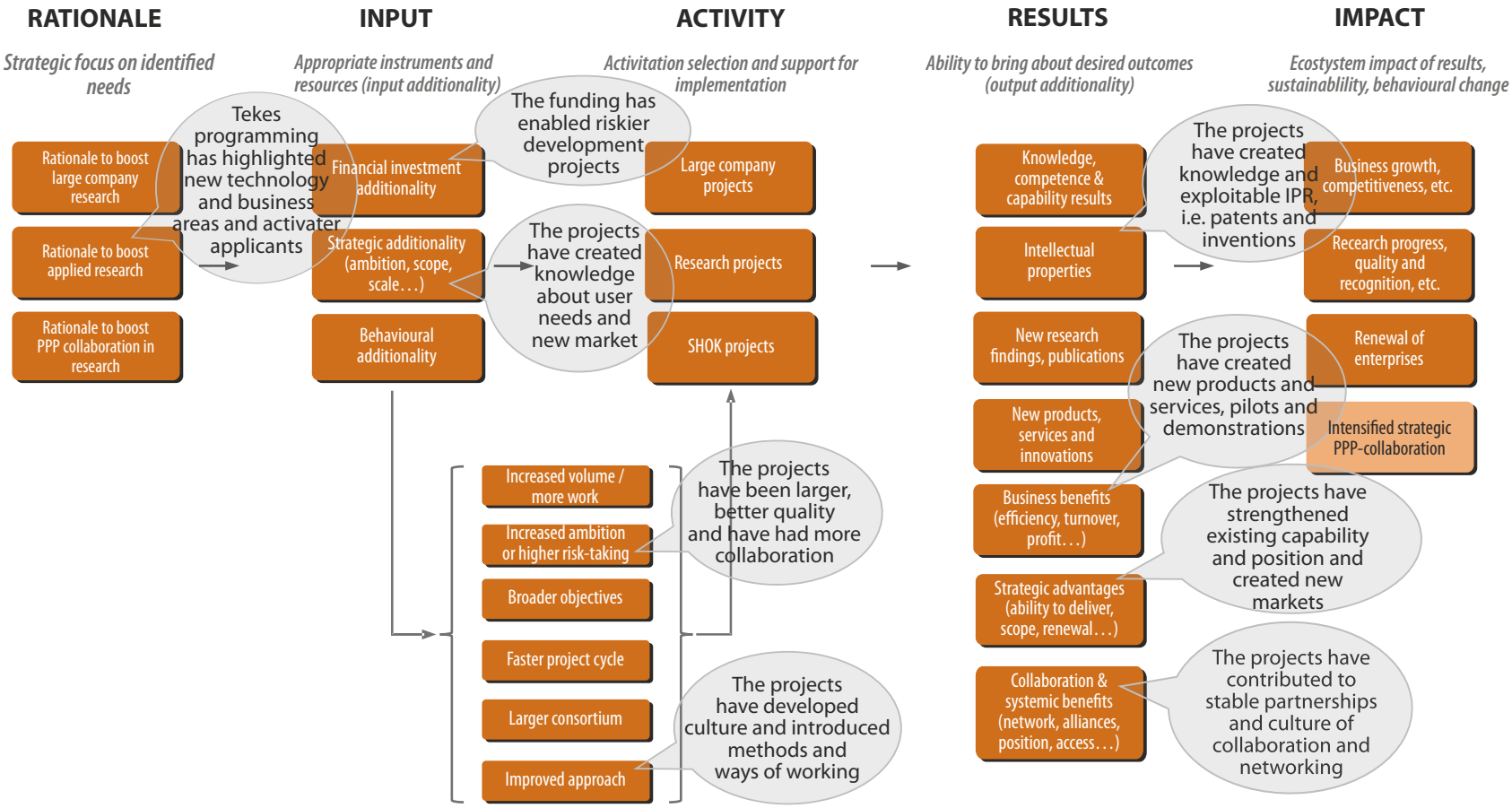
4.7 SUMMARY OF TEKES CONTRIBUTION

Starting from the general, it has been found in previous impact assessments that Tekes subsidies have positive impacts to growth and RDI intensity as discussed in the introduction. The following figure provides an overview to the contribution of Tekes funding in the various aspects of RDI. The contribution can be broken down also by levels of analysis. Based on the examined case studies, the contribution or additionality tends to be larger in larger, longer standing and really new projects. The input additionality can be seen at the Enterprise level, where: risk sharing enables developing more uncertain and really new projects and enables developing them in a more profound fashion. At the Ecosystem level, the projects have created new network connections and facilitated collaborations, created joint understanding of technology and end-user needs. At the Knowledge level: the projects have created knowledge about technology and markets, IPR, and demonstrations both reinforcing existing business and technology areas and highlighting areas that did not exist or weren't tangible.

Considering the output, the contribution can be classified to similar levels. First, there is *Leverage:* the projects have been completed with more scale and depth and with more quality than would have been possible without the funding. Further the projects have created *business, products and services:* the projects have contributed to technology development and products and increasingly services based on the technology. The projects have also attracted business and contributed to start-up activity in various business and technology areas. And thirdly the projects create *Knowledge:* the projects have created knowledge, IPR, and pre-commercial demonstrations. They have also highlighted new areas of business and technology for commercial exploitation.

Additionally, the funded projects have contributed to (eco-) system building and created systemic effects. The projects have broadened networks, introduced new partners to each other, and contributed to stable *partnerships and networks* beyond project duration. The projects have contributed *culture of innovation,* to renewal of ideas and practices in various organisations. At its most fundamental the projects have raised a new generation of researchers and managers into a new networked operating model. The projects have created *dialogue* between regulators, industry, researchers and end users to create mutual understanding of challenges and opportunities in given business areas. The projects have also contributed fundamentally to stabilising technology and business areas through joint understanding of the areas of technology and business and associated challenges.

FIGURE 32. Summary of contributions of Tekes funding.



Systemic effects. It is recognised that as Tekes's overall funding for the Big Three has been shrinking in recent years, although the funding for large enterprises has risen again in 2018, also the generated benefits have been diminishing. Not only are the direct benefits to the large enterprises, research organisations and SHOK programmes diminishing, but more importantly, the decreases in funding have hit in particular their interest and ability to collaborate amongst each other and the SMEs, hence particularly generating negative systemic effects.

The policy rationale for public support to large enterprise RDI investments is less related to the anticipated impact in addressing the market failure of under-investment. The rationale for, and added value of, supporting large enterprises comes from their ability to commit larger volume (than smaller enterprises) of research, raise the level of ambition in RDI projects, as well as from their ability to engage broader value chains into the projects and provide support for scaling innovations and business models to larger markets. At the same time, it is therefore essential that benefits also spread over all partners supporting the whole ecosystem, not only to the large enterprises directly. Unfortunately, these kinds of projects have been most severely affected by the changes in funding.

Relatedly, while there has been a push towards building ecosystems and platforms, there has been also less leadership and strategic thinking from the policy side on where to focus investments. At a more specific level, the interviews pointed out that the present instruments are not well suited for RDI infrastructures such as setting test environments and facilities, that have an important function as a platform that brings collaborators together.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 OVERALL CONCLUSIONS

The scene of Finnish RDI policy has changed significantly from the start of the study period in 2011 to the end of 2017. In the side of the business and economy, the ***structural change of the IT industry*** started along the 2008 financial crisis and the ripple effects continue until today, while various other changes are becoming all the more apparent. As a result, ***private sector investments to RDI***, which represent 2/3 of all RDI in Finland, ***have dropped significantly***. This has also affected the volume of business funded RDI in public research institutions, universities and in the SHOK programmes.

The economic crisis itself resulted in austerity measures during the last two governments which have directly affected Tekes budgets, public research funding, and for example the ***termination of the SHOK programme in 2015***. Key activities of SHOKs have however continued afterwards, but with less strategic commitment by the government.

In the side of research organisations, a ***major reform of public research organisations*** has been implemented in the same period. Not only were there significant structural changes at the research organisations (mergers and fusions), but this co-inside with ***reallocations and cuts in the budget appropriations***, as emphasis was shifted towards competitive funding through the Academy of Finland. While Tekes has traditionally been a major funder of applied research, its ***funding was also cut, and focus shifted towards enterprise RDI***. In in effect, the relative weight of academic (basic) research in the public RDI portfolio has increased, as universities' funding through budget appropriations and the Academy of Finland has been rather stable.

At the end of 2017, the organisations of ***Tekes and Finpro merged into present Business Finland***. As a consequence, the funding, services and priorities of Tekes and Business Finland changed towards more short-term results and less research funding, towards enterprises and particularly SMEs and start-ups, and also from subsidy towards loans.

It is evident that the rather simultaneous occurrence of these major changes in the innovation system and the resulted cuts in the volume and focus of RDI -funding, have significantly changed the overall interest and abil-

ity of the Big Three to conduct and collaborate in strategic RDI projects.

In the times of scarcity, the leveraging role of Tekes funding has become ever more important. The majority of enterprises and almost all researchers report that the projects would not have been conducted without the Tekes funding. For the most, the lowering of Tekes budget and associated changes in funding have negatively affected RDI volume and ability to conduct RDI, and their collaboration in particular.

5.2 CONTRIBUTION TO DEVELOPMENT OF PLATFORMS AND ECOSYSTEMS

The study shows that Tekes activities have contributed to building networks and ecosystems. Increase in collaboration has been both an important goal for many, and even more commonly an outcome of the project. The orientation of research organisations and HEIs has been towards collaboration with enterprises and in half of the cases towards piloting and demonstrations. Most importantly, the project outcomes show strengthened collaboration, building up particularly subcontractors and knowledge transfer to other enterprises, which signal that the projects encourage exchange and deepening of ties with partners.

One specific aim of Tekes funding to the Big Three has been to strengthen collaboration through platforms and ecosystems. Over the past years, Tekes has actively been supporting the creation of new collaboration platforms in areas such as health and well-being, edutech, gaming, etc. Furthermore, large companies often play a pivotal role in both technical platforms and in business and innovation ecosystems. Tekes funding for the Big Three provides an important incentive and even a requirement for collaboration and networking, hence strong emphasis on generating wider spill over effects. This has been well-demonstrated in case studies.

Two aspects should be emphasised regarding Tekes contribution to business and innovation ecosystems. First, they take time to grow, evolve and are not all viable over the long time. The ***life-span of an ecosystem is longer than typical Tekes project and even programme***. In reference to the case studies, the strongest ecosystems in Finland have taken a decade and more to build the relationships and align the interest of the parties. The support to building ecosystems should therefore be linked in the first instance to Business Finland strategy, rather than individual projects and programmes. The second aspect is the loose and ***self-organising nature of business and innovation ecosystems***, which makes it difficult, if not sometimes impossible, for a government agency like Tekes to initiate and lead the development of ecosystems. Having said this, the study shows Tekes has had an important role in supporting, promoting and boosting the development of business and innovation ecosystem with the Big Three projects.

The study results point out that the key benefits for the the Big Three organisations gained from R&D projects were pilots and demonstration., which often require research platforms and infrastructures. When pilots and projects are carried out in the context of collaborative projects, these infrastructures are often at disposal of the project partners. Thus, the utilisation of often capital demanding, infrastructures become more effective. However, ***the funding instruments of Business Finland lack specific support for research platform and infrastructure building***.

Two benchmarking cases in this study, Topsector and SIP, both showed to successful in bringing different stakeholders together, creating new partnerships and building ecosystems although their approaches for ecosystem building were different. The Swedish example SIP has bottom-up approach which could also be feasible operation model in Finland as countries have similar structures, face comparable challenges in society and have long tradition in Public-Private -partnerships.

One of the key learnings of this study is that the need for the more transformative, high-quality, high-value-added projects is as large as ever. This calls for courage in taking risks, but also long-term commitment in order to achieve results and building ecosystems. One concrete way is to adopt some version of the so-called DARPA- or mission-oriented approach for a limited number of selected areas at a time, i.e. ***the Big Three funding development of technology and business in general, proposing a challenging real-world problem and selecting consortia to solve the problem***. The advantage would be that completing the project would create public goods and give relevant references for the participating enterprises to leverage in export markets. At the same time, this would also require developing a whole-of-government approach to building programmes and securing commitment from the problem owners as much as any other stakeholder.

The study also shows that ***Tekes has had an important role in funding research in areas that do not yet have an established industry, or in areas that fall between academic disciplines***. Broadly networked projects can act as facilitators for starting a novel area and enhancing the ecosystem building by not only funding but bringing approval and attention to the topic.

The RDI, research projects and SHOKs have offered a platform for dialogue between industry, researchers, as well as policy makers and regulators, and users to co-create and develop solutions. Particularly ***SHOKs have contributed to creating networks and partnerships, but also have provided a platform and a mechanism to negotiate a joint view of future technology and its business uses***. This has enabled SHOK collaboration to contribute to wider technology platforms and standardisation in key areas. In recent year the public commitment to the SHOK programme and concept has been phased out, but Tekes has had continued contribution to the networks and ecosystems borne in SHOKs through programmes and projects.

5.3 CONTRIBUTION TO THE UTILISATION OF RESEARCH RESULTS, THE RENEWAL AND THE COMPETITIVE ADVANTAGE OF BUSINESSES

Tekes funded projects conducted by the Big Three are ambitious, complex and profound. These projects are aimed to create knowledge, competitiveness advantage, as well as new and improved products and services, and IPRs. Projects also contribute to identification, creation and stabilisation of new technology and business areas. This was clearly demonstrated both by survey results and case examples.

Tekes funding has had a risk-sharing function, hence it enables taking on riskier projects, raise the ambition and scope/depth of RDI. The public funding also affects internal dynamics in organisations, for example projects become easier to accept for go with outside funding and successful projects attract favourable management attention. ***Expertise in the funding agency also lowers the bar for entering into new areas.*** The projects also report that Tekes experts have added value into the process in helping highlight technological options and possible partners, and by helping evaluate them.

Tekes funded applied research projects have created a wealth of IP, new technology and highlighted new business areas, but the bottleneck is finding the path to commercialisation, as illustrated by the case studies**.** One potential approach here could be ecosystem building approach, where ecosystem has the responsibility for commercialisation of the results, and thus finding the ways and right partners to meet this requirement.

Then stereotypically enterprise-led projects have contributed specifically to renewal of enterprises internal process and practices as well as products and services, but they are more incremental and conservative, more typically an extension of existing business. ***While broadly networked projects have more apparent and broader benefits for ecosystem building, networking and collaboration, and applied research tend to be more transformative, ”traditional Tekes projects” with clear solution focus and limited consortium also do add value to R&D and help renew organisations and their processes and practices.*** The case studies also showed that Tekes funding played a significant role in ensuring the future competitiveness and building new partnerships that brought along expertise for tackling with novel technology areas.

The added value of large collaboration efforts specifically includes cultural change and also contributions to standardisation. The interviewees recognise the value of the SHOK programmes as an effort to build trust and a culture of collaboration between the various actors. The large programmes are also an opportunity to invest in standards development other major efforts not otherwise feasible.

The case studies indicate that ***Tekes projects have contributed to building 'an innovation culture'*** that is conducive to developing new ideas and practices. These factors together support renewal of enterprises and broadening of knowledge and business areas.

5.4 IMPACT IN THE FINNISH ECONOMY AND SOCIETY

The data suggest that Tekes has created most added value through substantial and transformative projects and programmes. Large enterprises and research organisations are generally established and professional organisations that have a capability to run complex and demanding RDI projects. Thus, ***it seems that when addressing these target groups, Business Finland can create the most additionality by seeking the more transformative and high-quality, high-value-added projects*** – the kinds of projects that challenge existing value chains and tend to fall between industries or be deemed too risky to undertake otherwise.

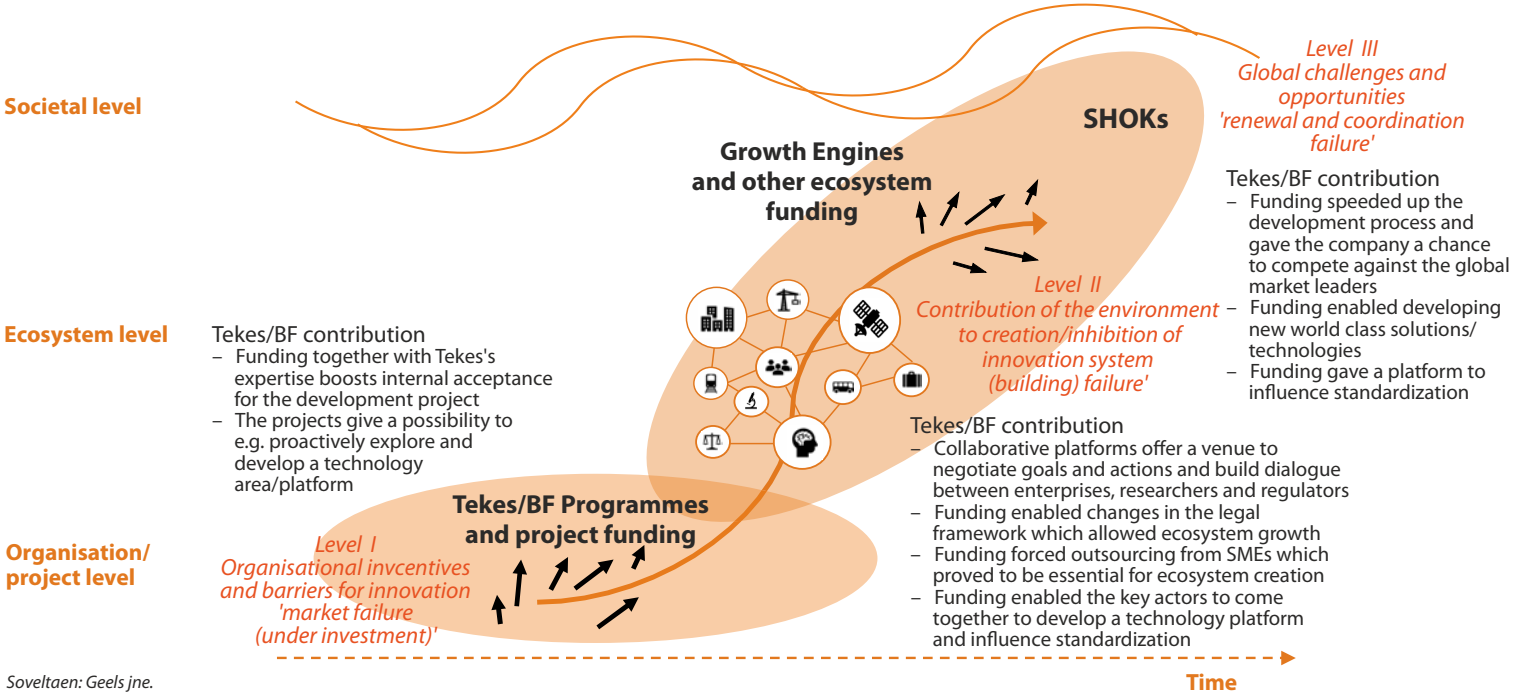
While in general, there are significant externalities from R&D, up to 40 percent of the benefits spreading outside the original partners, the policy rationale for public support to large enterprise RDI investments is less related to the anticipated impact in addressing the market failure of under-investment. ***The rationale for, and added value of, supporting large enterprises comes from their ability to commit larger volume (than smaller enterprises) of research, raise the level of ambition in RDI projects, as well as from their ability to engage broader value chains into the projects and provide support for scaling innovations and business models to larger markets.*** At the same time, it is therefore essential that benefits also spread over all partners supporting the whole ecosystem, not only to the large enterprises. Unfortunately, these kinds of projects have been most severely affected by the changes in funding.

Relatedly, ***while there has been push towards building ecosystems and platforms, there has been also less leadership and strategic thinking from the policy side on where to focus investments***. At a more specific level, the interviews pointed out that the present instruments are not well suited for RDI infrastructures such as setting test environments and facilities, that have an important function as a platform that brings collaborators together.

The following figure also summarises the different roles of Tekes activities, which have slightly different contributions. At the bottom, programme and open call project funding in its part has a relevant role in developing technology, services and business concepts broadly. These the "traditional Tekes projects" that solve specific problems effectively and, in the process, have additionality by creating behavioural and

output additionality. At the next level, Tekes funding has created platforms through programmes, funding consortia and infrastructure, and SHOK funding for enterprises to create networks and value chains. Finally, at the most far reaching, Tekes activities have enabled Finnish enterprises to challenge international competition and for example influence standards and define the global business area.

FIGURE 33. Summary of the contributions towards ecosystems and platforms.



Soveltaen: Geels jne.

5.5 POLICY RECOMMENDATIONS

The mainstream of RDI policy in the recent years has focused on the support for SME, particularly the fast growing, internationally-oriented and start-ups. In a slight departure from this orientation, we recognise that a significant part of knowledge creation and ambitious RDI projects are in fact led by large enterprises, dedicated research organisations and their collaborations such as the SHOKs – the Big Three. These are the professional RDI organisations with teams and resources to invest in and often to connect and exploit innovation effectively. The essential question is how to attract and engage the Big Three into research endeavours that benefit knowledge creation, business ecosystems and the society at large. ***The study reveals that, unfortunately, the overall conditions for effective research collaboration amongst the Big Three and others, have not developed to the positive direction over the last decade.*** Finland is quickly falling behind the development of strategic RDI hubs, which should be systematically addressed. It is therefore even more important for the Business Finland to carefully consider how to smartly base its bets.

The study concludes that ***there is an evident need in Finland to step up – and to some extent rethink – the support measures for professional, ambitious and large-scale RDI activities***. Hence, the following recommendations are made with the objective to boost the overall impact and effectiveness of RDI support to large enterprises, research organisations and strategic research coalitions (such as SHOKs). Our recommendations are structured into following three topic areas, of which particularly two first ones are in the core of Business Finland strategy.

5.5.1 DEDICATED STRATEGIC RDI MEASURES IN RESPONSE TO IDENTIFIED ECONOMIC AND SOCIETAL CHALLENGES AND OPPORTUNITIES

Tekes has traditionally had a strong process for recognising future societal needs and technological opportunities. Answering to present and future challenges continues to need making choices and investing strategically into development of knowledge, technology and business models. ***Business Finland can, and should continue the foresight activity and have a key role in offering a platform for strategic discussion and making choices but needs to recognise and involve the pertinent stakeholders for making these decisions and committing them to the process.***

To avoid parallel and overlapping structures and funding, the ecosystem approach should be delineated with larger policy goals, such as Government priorities and commitments, and coordinated with the new Growth Engines and Flagship initiatives from Academy of Finland and with regional efforts to build ecosystems. The Topsector approach is a good example of substantial Government commitment to a stable framework, that has been adjusted over time following changing societal

needs and priorities. Lastly, the national ecosystem efforts should also take international reference documents such as EU RDI priorities and Sustainable Development Goals into account, to create a continuum for Finnish actors to proceed towards international fora.

When it comes to funding ecosystems and platforms, they should be attached to a strategic agenda that the stakeholders are committed to. Any successful ecosystem needs to create added value in some form for all participants, and the inception of ecosystem needs a process to negotiate an agenda and sharing of value. For example, the Swedish SIP model is a good example of an open selection process where consortia can propose strategic agendas, that are evaluated against various policy goals and the selected get a funding for a platform that coordinates the implementation of the strategy.

5.5.2 FROM PROGRAMMES TO STRATEGIC RDI ECOSYSTEMS AND PLATFORMS

The funding for the Big3 should be strengthened with an emphasis on collaboration and creation of ecosystems. While platforms and ecosystem funding and strategies are important, but the actors need to also have incentives to engage in RDI projects together.

The challenge is that many actors around Finland are founding and funding various kinds of ecosystems and platforms. As discussed in previous, ***Business Finland should aim to consolidate and coordinate between the other initiatives, including Academy's Flagships and Growth Engines to focus on a limited number of the most ambitious, significant, and promising ecosystems at a time***, set specific substantive objectives besides an abstract revenue number and monitor and review the portfolio continuously. Business Finland already has the basic tools to set incentives for the actors, what is needed is formulation of the framework and setting funding for platforms and infrastructure for RDI and business ecosystems.

The ecosystems need to be open and enabling, but selective to focus resources and efforts of partners who are committed to delivering outcomes. Whereas the SIPs are an example of the selection process, SHOKs have good practices of building consortia around a solid core of committed and experienced actors with a good track record in delivering outcomes, and introducing new partners to the mix, with clear objectives and yearly performance reviews for all partners.

5.5.3 AMBITIOUS, HIGH-QUALITY COLLABORATIVE RDI PROJECTS AND PROGRAMMES IN PROMISING GROWTH AREAS

The data in this study indicates that Business Finland creates most added value in large, far reaching and technologically ambitious and transformative projects, that are also the easiest to fall between various organisations core mandates. ***Also, for the ecosystem policies to work, the system needs sufficient flow of projects***

that enable developing technological platforms and applications, and Business Finland has an important role here. Business Finland has unique leverage in being able to fund these projects and they should focus on selecting and putting together the best consortia between industry and research organisations.

While the traditional programmes are very much liked by the customers and also the outcomes are good, ***the programming cycle should be sensitive to industry conditions and more conditional to specific 'victory condition'***, as in programme end could be tied to a specific roadmap or other strategic criteria rather than a specific time. As an example, in pharmaceuticals and medical technology 10–15 years is a normal product development cycle, while in mobile apps 10–15 months is closer to normal, these differences in industry structures and business cycle should not be ignored in programming. This orientation would reinforce the structure of making strategic choices and implementing them consistently. However, this also poses more pressure on building the programmes and knowing the industry and actors and gauging whether they are ready in earnest to commit to a strategic RDI programme and able to use the results, and for monitoring the programmes and adjusting roadmaps and funding to ensure the programmes are progressive.

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ANNEXES

SUMMARY OF KEY FINDINGS REGARDING THE MAIN GROUPS

A. Key findings regarding funding for large enterprises	
Questions	**Key findings**
How has the level of funding developed over time, what has been the focus and type of beneficiaries, partners, etc.	• There has been a dramatic drop of funding (from 2010 until 2016), hitting particularly research organisations • Other RDI-funding organisations have not had similar cuts • Focus of Tekes funding has shifted towards loans
What has been a role of Tekes projects in large enterprise R&D investments?	• Tekes projects have a role in risk sharing, enabling more ambitious and larger RDI projects • Tekes funding has had significant leverage in encouraging private investment
What has been the input additionality and role of Tekes projects in large enterprise R&D investments?	• Tekes funding has leverages about three times the funding volume (including loans)
How large enterprises have utilised 1) to develop the product or service, 2) piloting the features of a new, innovative solution and 3) creation of new knowledge, by improving their competitive advantages in the economy? What kind of changes in practices have been generated?	• Pilots and demonstrations together with new processes, products and services are among the most common outcomes form the projects • Large enterprises have used the funding both to improve their competence and capabilities as well as tangible products and services • The projects may start as product or service focused, but along the way the development work introduces behavioural additionality, such as networking, adoption of new practices and changes in organisation attitudes and culture towards innovation

B. Key findings regarding funding for research organisations	
Questions	**Key findings**
How has the level of funding developed over time, what has been the focus and type of beneficiaries, partners, etc.	• There has been a dramatic drop of funding (from 2010 until 2016), hitting particularly (public) research organisations • The basic funding of research organisations has dropped, too • There have been significant organisational revisions in the public research sector
What have been the results and outcomes of Tekes funded research projects.	• The funding for research organisations has created naturally knowledge and publications, but also significant IPR, inventions, pilots and demonstrations and contributed to new products and services, and start-ups
What has been the input additionality and role and impact of Tekes projects in research organisations, and especially the impact on co-operation?	• Same as above, Tekes funding enables more ambitious and larger RDI projects • The input additionality in terms of investment is less pronounced than for large enterprises, but rather the according to almost all research organisation who responded in the survey the projects would not have undertaken without the funding • Funding also has had a function in enabling collaborations that would not be possible otherwise
How results of research-led projects have been utilised by participants and other stake holders (spill overs)? What kind of changes in practices have been generated?	• All beneficiaries report knowledge transfer as result of the projects, and very commonly research organisations also report pilots and demonstrations as a result • The ROs are actively pursuing solutions to industrially relevant problems and also actively communicating their results for stakeholders in the industry
Comparison of strengths and weaknesses of funding for large enterprises, including Co-creation, Strategic research openings, and Traditional research projects?	• Based on the data, Strategic Openings have had potentially the most significant effect per project, overall the added value of Tekes funding seems to be most pronounced when the projects are substantial in size, relatively long in duration and aim for really new or radical innovations

C. Key findings regarding funding for SHOKS	
Questions	**Key findings**
How has the level of funding developed over time, what has been the focus and type of beneficiaries, partners, etc.?	• The programme was well-funded to begin with, but rather abruptly phased out between 2015-2017
What have been the results and outcomes of Tekes funded SHOK projects. **How results of SHOK projects have been utilised by participants and other stakeholders?**	• The SHOK programmes have had a significant role in enabling the scale and scope of development that has brought for example large enterprises together and enabled contributions to standards and created a platform for substantial and far-reaching development
What has been the input additionality and role of Tekes projects in SHOKs, and what is the impact of co-operation with the enterprises?	• As captured in the funding data, the leverage of SHOK funding is average • However, SHOKs have greatly contributed to collaboration between research organisations and enterprises
How results of SHOK projects have been utilised by participants and other stakeholders (spill overs)? **What kind of changes in practices have been generated?**	• The SHOKs results are famously hard to track in terms of products and services, but the programmes have created a platform for negotiating strategic agendas and building consensus for example related to standards • In terms of behavioural additionality, the SHOKs have also contributed to creating lasting networks and culture of collaboration