REVIEW 318/2015

The Impact of Tekes on Capabilities

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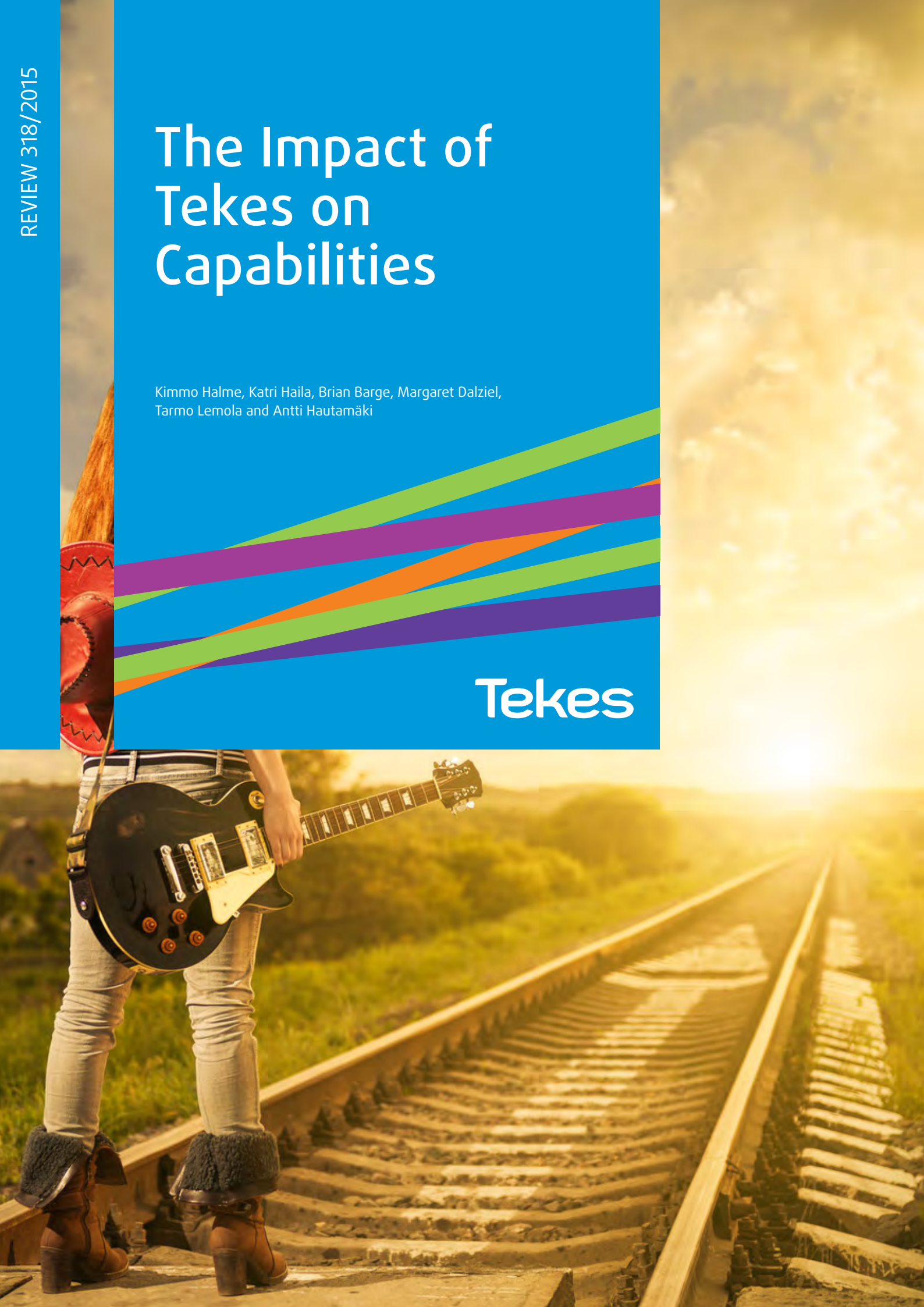

Tekes

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Tekes – the Finnish Funding Agency for Innovation
Tekes is the main public funding organisation for research, development and innovation in Finland. Tekes funds wide-ranging innovation activities in research communities, industry and service sectors and especially promotes cooperative and risk-intensive projects. Tekes' current strategy puts strong emphasis on growth seeking SMEs.

Tekes programmes – Tekes´ choices for the greatest impact of R&D funding
Tekes uses programmes to allocate its financing, networking and expert services to areas that are important for business and society. Tekes programmes have been contributing to changes in the Finnish innovation environment over twenty years.

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Foreword

Finnish wellbeing is based on the wealth and jobs created by the success of Finnish companies on the global market. In terms of capabilities, Finland ranks among the top countries according to several different indicators.

The main framework of this evaluation was how Tekes activities have practically succeeded to improve capabilities in public research and large company research projects in Finland. For example: How Tekes activities have succeeded to develop renewing working methods and forerunning capabilities? What is a role of capabilities to improve forerunning and renewal in the research organizations, universities and large firms? What is the impact of forerunning capabilities on the whole economy and society?

Logic of measuring renewal of capabilities is that old-fashioned working methods find new ways through transition. Old-fashioned methods have a culture of the contracting behavior which does rationalize its existence by explaining the introverted causes and consequences. In other words, locked culture of working methods is unable to find new perspectives which create new successful paths. As a result, renewing methods give tools for forerunning capabilities.

Renewing methods are essential in order to build up forerunning capabilities. They give tools to solve problems which have radical outcomes. Capabilities need creative thinking that identify goals and find alternative solutions. In Tekes strategy, forerunning capabilities tend to broaden international of innovation activities. Moreover, their role is essential to strengthen networking activities. In addition, Tekes would like researchers to take on the role of business life visionaries whose research results create preconditions for new business operations.

The general conclusion of the evaluation is that innovation capabilities are important and Tekes research, development and innovation funding has had a clear and significant positive impact on the overall accumulation of innovation capabilities of research organizations and large firms.

Also evaluation results show that Tekes has succeeded well in improving different types of capabilities. On average, the highest impact was on networking, whereas the impact on internationalization activities was weak. However, the differences between impacts on various capabilities should be studied carefully and compare to general targets (like renewing industries) of Tekes.

This impact study was carried out by Ramboll Management Consulting Oy, The Evidence Network, LC Group and Sustainable Innovation. Tekes wishes to thank the evaluators for their thorough and systematic approach. Tekes expresses its gratitude to steering group and all others that have contributed to the evaluation.

Tekes – the Finnish Funding Agency for Innovation

Tiivistelmä

Ramboll ja *The Evidence Network* selvittivät Tekesin vaikutuksia kyvykkyyksiin, joka on yksi Tekesin strategian kolmesta päämääräalueesta: tuottavuus ja uudistuminen, ihmisten ja ympäristön hyvinvointi sekä innovaatiotoiminnan kyvykkyydet. Selvityksen kohderyhmänä olivat **suuryritysten ja tutkimuslaitosten t&k-hankkeet**. Selvitykseen sisältyi dokumenttianalyysi, sähköinen kysely, hankkeiden jälkiseuranta-aineiston tilastollinen analyysi, tapaustutkimukset haastatteluineen ja validointityöpaja.

Kokonaisuudessaan Tekes on onnistunut hyvin tavoitteessaan edistää innovaatiotoiminnan kyvykkyyksiä. **Tärkein vaikutuskeino on ollut yhteistyön ja verkostoitumisen edistäminen.**

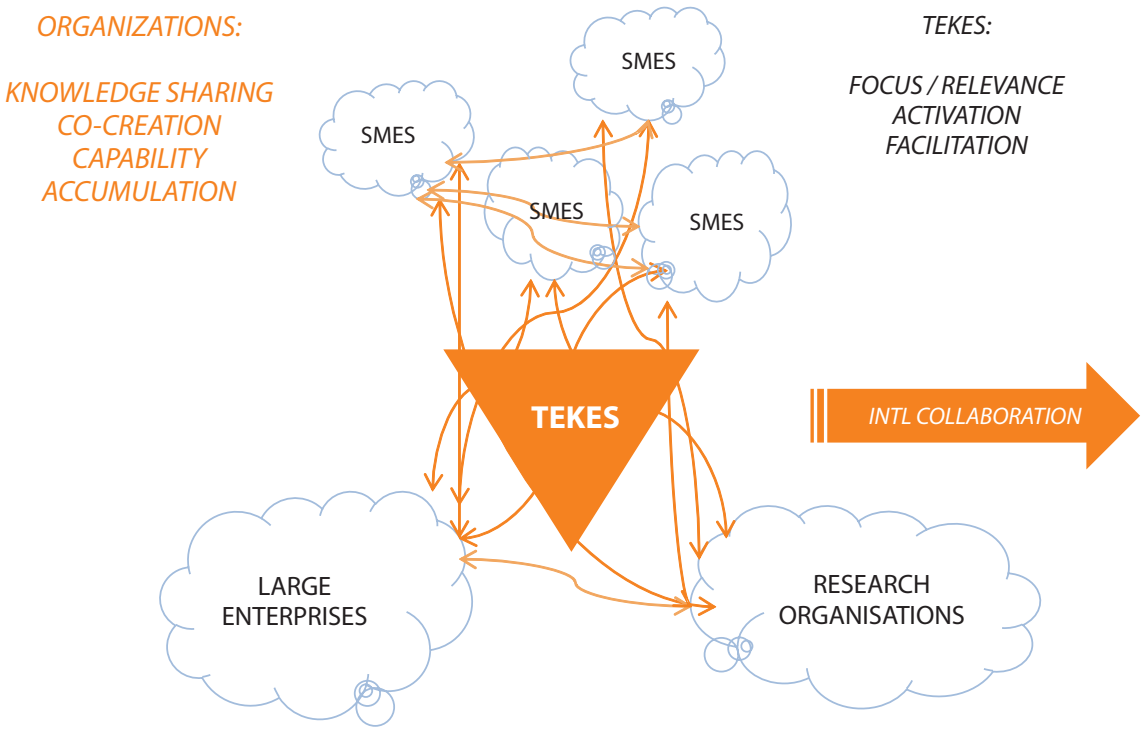
Tekesillä on hyvin merkittävä rooli suuryritysten, pk-yritysten ja tutkimuslaitosten välisen yhteistyön mahdollistajana ja edelleen innovaatiotoiminnan kyvykkyyksien ja osaamisten siirtojen edistäjänä (kuvio).

Tekes-hankkeiden ansiosta niin suuryritysten kuin tutkimuslaitosten yhteistyö pk-yritysten kanssa on lisääntynyt.

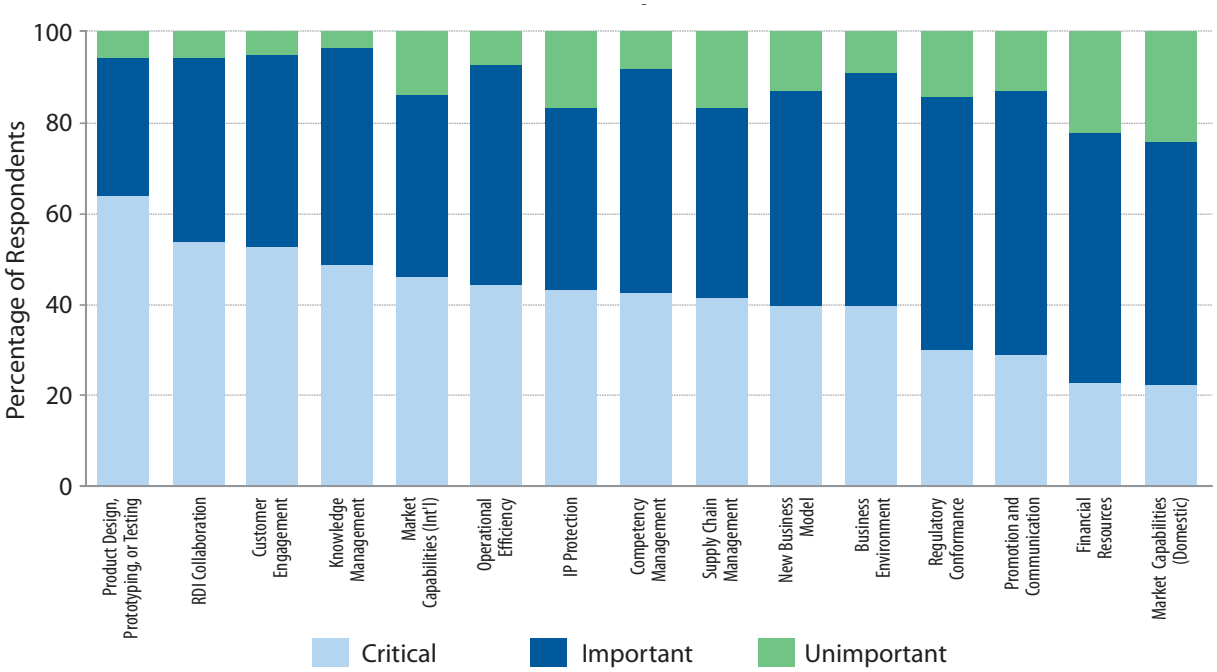
Kyvykkyyksien edistämisessä Tekes onnistui heikoiten tutkimus- ja innovaatiotoiminnan kansainvälistymisen edistämissä.

Keskeinen kysymys on, mitä ongelmaa kyvykkyyksillä ratkaistaan. Tulevaisuudessa olisi tärkeää keskittyä niihin kyvykkyyksiin, joissa Tekesillä on olennaista annettavaa. Muiden kyvykkyyksien osalta tulisi sopia työnjaosta muiden toimijoiden kanssa. Esimerkiksi kansainvälistymisen valmiuksia koskien tulisi sopia tarkemmasta työnjaosta Team Finland -toimijoiden välillä ja kasvurahoitukseen liittyen työnjaosta eri toimijoiden välillä.

Kuvio 1. Tekesin rooli kyvykkyyksien edistäjänä.



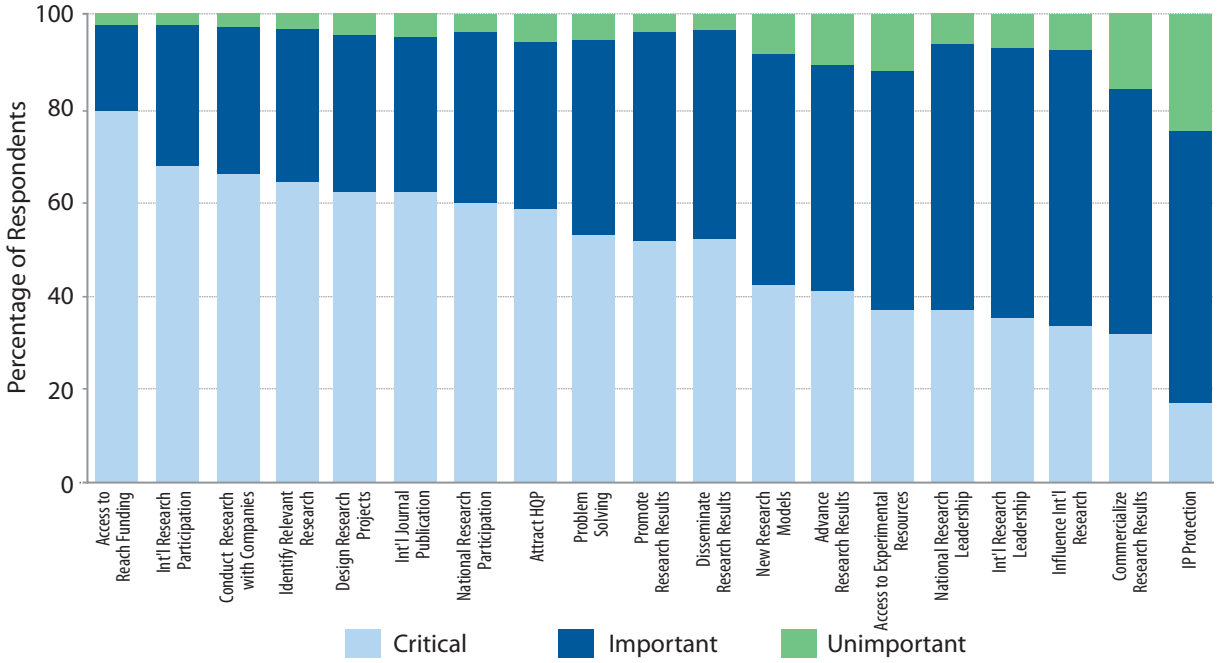
Kuvio 2. Eri kyvykkyyksien tärkeys suurille yrityksille. 81 % yrityksistä ilmoitti että heidän kyky suunnitella, testata ja kehittää tuotteita on vahvistunut Tekesin rahoituksen myötä.



Tekesin roolina on muutoksen agenttina toimiminen. Uudistumisen haastetta koskien keskeinen kysymys on, mitkä kyvykkyydet tukevat uudistumiskykyä. Pelkkä osaamisen vahvistaminen ei tähän välttämättä riitä. Pyrkimyksenä onkin "toisen asteen" kyvykkyyksien vahvistaminen. Lisäksi on otettava huomioon, että uudistuminen on tapauskohtaista ja esim. uusien liiketoimintamallien ja kansainvälistymisen edistämisessä tarvitaan erilaisia kyvykkyyksiä. Uudistumista tapahtuukin monella eri tasolla. Jos uudistuminen asetetaan keskeiseksi tavoitteeksi, uudistuminen tulisi täsmentää ja sitä tulisi lähteä viemään eteenpäin.

Selvityksen myötä nousi useita tutkimustarpeita koskien kyvykkyyksiä esim. aineettoman pääoman kyvykkyyksien kehittäminen (IPR, standardien hyödyntäminen), kuinka huomioidaan yhteiskunnan kyvykkyyden kehittäminen (SOTE jne.) ja onko kyvykkyyksissä eroja toimialojen välillä.

Kuvio 3. Eri kyvykkyyksien tärkeys tutkimusorganisaatioille. 80 % tutkimusorganisaatioista ilmoitti että kyky saada tutkimusrahoitusta on heille kriittistä. 76 % ilmoitti että heidän kyky arvioida ja kehittää uusia tutkimusmalleja on parantunut Tekesin rahoituksen myötä.



Suositus 1: Kyvykkyyksien täsmällisempi määrittely juuri Tekesin näkökulmasta. (ks. Taulukko 23, s. 109). Tutkimus- ja innovaatiotoiminnassa tarvitaan erilaisia kyvykkyyksiä, eikä yhtä vallitsevaa viitekehystä ole käytössä. Siksi Tekesin kannattaa määritellä omaan tehtäväänsä soveltuva viitekehys. Vaikuttavuuden kannalta viitekehyksessä on hyvä huomioida sekä suorat kyvykkyydet, että erityisesti ns dynaamiset kyvykkyydet (organisaatioiden kyky vahvistaa omia kyvykkyyksiään).

Suositus 2: Keskittyminen sellaisten kyvykkyyksien vahvistamiseen, joissa Tekesillä on selkeä lisäarvo. Kyvykkyyksiä on monenlaisia ja -tasoisia, ja kehittämistarpeet vaihtelevat runsaasti. Tekesin suurin lisäarvo liittyy strategisen TKI-toiminnan edellytysten vahvistamiseen, usein yhdistämällä rahoitusta ja muita palveluja. Vaikuttavuus paranee, kun tarjonta räätälöidään eri kohderyhmien tarpeiden mukaisesti.

Suositus 3: Vaikutukset pienten ja keskisuurten yritysten kyvykkyyksiin selvitettävä erikseen. Tässä selvityksessä keskityttiin suuriin yrityksiin ja tutkimusorganisaatioihin. Kokonaiskuva ei ole kattava, jos Tekesin keskeinen kohderyhmä on vain välillisesti mukana.

Suositus 4: Huomiota järjestelmätason kyvykkyyksiin, korostaen talouden uudistumista. Kyvykkyyksien vahvistumista on tärkeää tarkastella myös yrityksiä ja organisaatioita laajemmin, systeemisenä ilmiönä; kuinka Tekesin toiminta on vahvistanut klusterien tai liiketoimintaekosysteemien kyvykkyyksiä ja erityisesti niiden edellytyksiä kehittyä ja uudistua (i.e. kyetä itse vahvistamaan kyvykkyyksiään).

Suositus 5: Kyvykkyystavoitteiden toimeenpanon ja tuloksellisuuden seurannan kehittäminen. Tällä hetkellä kyvykkyyttä koskevia tavoitteita ei ole operationalisoitu niin, että tiedettäisiin kuinka näihin tavoitteisiin pyritään ja miten edistystä mitataan. Siksi myös tavoitteiden saavuttaminen ei ole yksiselitteistä ja toiminnan ohjattavuus on huono. (ks. Kuvio 54, s. 112)

Suositus 6: Tekesin rahoitus on kriittistä tutkimusorganisaatioille, erityisesti tutkimuksen kaupallistamisen näkökulmasta. Muun rahoituksen (so. yritys- ja perusrahoituksen) vähenemisen vuoksi Tekesin suhteellinen merkitys rahoittajana on korostunut. Näin varsinkin yhteishankkeiden ja tutkimustiedon levittämisen rahoittamisessa, johon tällä hetkellä ei ole juurikaan muuta rahoitusta saatavilla. On tärkeää varmistaa tutkimusyhteistyön jatkuminen ja kehittyminen.

Table of Contents

1 Introduction

1.1 Background

In market economies it is the role of firms to find solutions to basic economic issues i.e. how can products and services needed by society be produced in a way that is economically sustainable. Firms develop strategies when they choose product markets in which they want to compete and technologies with which they hope to achieve competitiveness. Firms engage in financing when they make investments to acquire technologies or access markets to generate revenues. Firms organize when they combine resources in an attempt to transform them into saleable products.

It follows, that basically firms operating in competitive market environment are themselves in charge of maintaining and upgrading their capabilities related to strategies, financing, organizing, technologies, innovation etc. They have the highest motivation and best knowledge to do that. In principle, firms have three ways to acquire and develop their capabilities: they *make* capabilities within the firm, *buy* them from market, or develop them in various kind of *collaborative* arrangements (learning from other companies, universities, research institutes, users etc.). The types of managing capabilities change over time and can vary markedly across industrial sectors and in various sizes of firms. By and large, the importance of collaboration various kind of collaborative ventures has been increasing, with open innovation as one of latest examples.

What has been said above about firms is very much true of universities and research institutes, too. They are operating nationally and internationally more and more in competitive frameworks. To be able to maintain and improve their competitiveness they have to develop their capabilities actively, and not only R&D capabilities but also several other capabilities. In the development of their capabilities universities and research institutes use the similar mechanisms as firms: making, buying and collaborating.

According to Tekes' strategy[1],Tekes has three main target areas: 1) Productivity and renewal of industries; 2) Capabilities, and 3) Well-being and environment. As agreed between the governing body of Tekes, the Ministry of Employment and the Economy, and Tekes, the impact assessments within each target area comprise the actual and official method for monitoring Tekes success and impacts. The present impact study on capabilities has been commissioned by Steering and networks unit of Tekes.

With regard to capabilities, Tekes' objective is to develop such capabilities that are needed to generate innovations. The requirements of successful innovation activities include the strengthening of competences and utilisation of the best national and international networks. Tekes has defined the specific capability areas as follows: 1) The competences utilised and the transferring of competences, 2) The internationalisation of research and innovation activities, 3) Agile user-driven innovation processes, 4) National and international cooperation networks and test environments, and 5) Atmosphere that encourages entrepreneurship, cooperation, experiments and continuous renewal[2].

The report at hand presents the results of the study on impact of Tekes on capabilities. The report is structured as follows:

- Chapter 1. Introduction
- Chapter 2. Framework and methodology
- Chapter 3. Results
- Chapter 4. Conclusions and recommendations

1.2 What is capability?

To assist in the identification of a set of capabilities to be used in the assessment of changes in companies' capabilities and the importance of Tekes' impact on companies' capabilities, we created a capabilities classification scheme based on the research literature. The benefit of this approach is that it allows us to identify missing, redundant, and ambiguous capabilities in an effort to arrive at a list of capabilities that is appropriate to the assessment project.

Nelson (1982) described the evolution of organizational capabilities. At the core of these capabilities, as firms deal with uncertain environments, are routines that provide managerial guidance and efficiency. Winter (2000: 938) further defines an organizational capability as "a high-level routine (or a collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing signif-

1 Tekes strategy 2014 www.tekes.fi

2 Tekes strategy 2014 www.tekes.fi

icant outputs of a particular type." Our classification scheme first distinguishes between ordinary and dynamic capabilities. We then segment ordinary and dynamic capabilities into more specific categories based on widely accepted frameworks. Finally, we distinguish between exploration and exploitation capabilities from an organizational learning perspective. The resulting classification scheme shows that our list of 15 capabilities provides reasonable coverage of all types of capabilities.

Appendix A provides an ordered list of our 18 capabilities; Appendix B provides an ordered list of Tekes' 17 capabilities; and Appendix C provides a mapping between our 18 capabilities and the list of 17 capabilities provided by Tekes.

1.2.1 Ordinary Capabilities *versus* Dynamic Capabilities

Ordinary capabilities allow organizations to operate their chosen lines of business efficiently and effectively, while dynamic capabilities help them to upgrade their ordinary capabilities, or to create new ones (Winter, 2003). A recent study by Teece (2014) indicates that ordinary capabilities are orchestrations of the company's resources that enable an existing product or service to be made, sold, and serviced, while dynamic capabilities are orchestrations of the company's resources that enable the company to (1) identify and assess opportunities (sensing), (2) mobilize resources to address opportunities and to capture value from doing so (seizing), and (3) continuously renew itself (transforming). Ordinary capabilities constitute the technical fitness of the company, while dynamic capabilities assist in achieving the evolutionary fitness of the company (Teece, 2007; 2014).

1.2.2 Ordinary Capabilities

Ordinary capabilities, also referred to as 'zero-order' capabilities, are defined as those enabling firms to 'make a living' in the short term (Winter, 2003). That means ordinary capabilities are a particular set of capabilities that help firms to function operationally and generate revenues on a continuous basis (Winter, 2003; Helfat and Winter, 2011). Specifically, ordinary capabilities are about producing and selling a defined (and static) set of products and services (Teece, 2014). Collis (1994) first proposed that there are distinct levels of organizational capabilities and therefore suggested four categories of capabilities. The first two categories are considered as ordinary capabilities in our approach. Specifically, the first category capabilities "are those that reflect an ability to perform the basic functional activities of the firm" (Collis, 1994: 145); they are the firm resources in the broad sense. The second category of capabilities, which are concerned with improvements to firm activities, are modifications of the resource base.

We identified subcategories of ordinary capabilities in accordance with Winter (2003) and Helfat and Winter (2011), who emphasize the capacity to operate within the existing business model. Our approach is also consistent with Drnevich and Kriauciunas (2011). Their discussion of ordinary capabilities focuses on a firm's ability to enhance its operations or its products and services, without altering them fundamentally. Our two sub-categories of ordinary capabilities are: 1) market and environment related; and 2) technology and operations related.

1.2.2.1 Market and Environment Related

Market and environment related capabilities enable firms to perform an activity on an on-going basis using more or less the same techniques on the same scale to support existing products and services for the same customer population (Helfat and Winter, 2011). Examples of market and environment related capabilities include engagement with potential customers, management of distribution channels etc.

1.2.2.2 Information and Operations Related

Information and operations-related capabilities allow organizations to operate their chosen lines of business efficiently and effectively (Winter, 2003). Examples of information and operations related capabilities include evaluation and adoption of new technology, management of supplier networks, improvement of operational efficiency, and etc. Table 1 shows the identification and categorization of the most important ordinary capabilities.

Table 1. Categorization of Ordinary Capabilities.

Ordinary capabilities	
Market and environment related (including societal challenges)	1. Engagement with potential customers and end users to gain an understanding of unmet market and societal needs 2. Market intelligence, and management of distribution channels 3. Promotion of corporate products, processes, or services
Information or operations related	4. Evaluation and adoption of new knowledge, information, technology, products, processes, or services 5. The management of supplier networks 6. Increasing operational efficiencies

1.2.3 Dynamic Capabilities

Dynamic capabilities are defined as 'the ability to sense and then seize new opportunities and to reconfigure and protect knowledge assets, competencies, and complementary assets with the aim of achieving a sustained competitive advantage' (Teece et al., 1997; Augier and Teece, 2009). This definition is consistent with Helfat et al. (2007) who define dynamic capabilities as *'the capacity of an organization to purposefully extend, create, or modify its resource base'*. Similarly, Eisenhardt and Martin (2000) define dynamic capabilities as 'the firm's processes that use resources, specifically the processes to integrate, reconfigure, gain and release resources to match and even create market change.' According to Collis (1994), the third category of capabilities is about the creation and extension of resource base. The third refers to the ability "to recognize the intrinsic value of other resources or to develop novel strategies before competitors" (Collis, 1994: 145). The fourth category is defined as higher order 'meta-capabilities' and it relates to learning-to-learn capabilities. We classify Collins' third and fourth types of capabilities as dynamic capabilities. The building of dynamic capabilities is shown in Figure 1.

Dynamic capabilities reflect a firm's ability to reconfigure its capabilities to adapt to its environment (Sapienza et al., 2006). They also embrace the firm's capacity to shape the ecosystem it occupies, develop new products and processes, and design and implement viable business models (Teece, 2007). To classify dynamic capabilities, we relied on Eisenhardt and Martin (2000) that argue that dynamic capabilities are a set of specific strategic and organizational processes such as product development, strategic decision marking, and alliancing that create value for firms within dynamic markets by manipulating resources into new value-creating strategies.

1.2.4 New Product and Service Development

New product and service development is a dynamic capability that integrates resources and enables firms to continually introduce new products and adapt to changes in technology and markets (Helfat and Raubitschek, 2000). Specifically, managers combine their varied skills and functional backgrounds to innovate and to create revenue-generating products and services (Helfat and Raubitschek, 2000; Eisenhardt and Martin, 2000). Examples of new product and service development include design and test of new product prototypes, IP protection, etc.

1.2.5 Strategic Decision Making

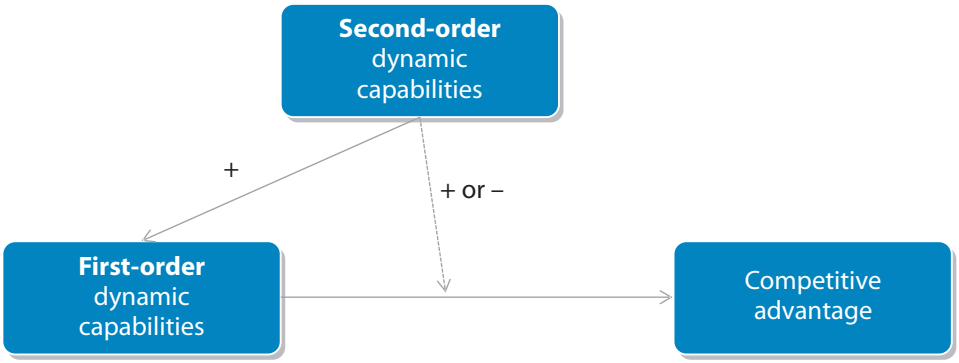
Strategic decision making is also a dynamic capability that integrates resources. Developing decision-making skills and organizational processes to sense and seize opportunities is an essential managerial function and it is embedded in the dynamic capabilities framework (Augier and Teece, 2009). Specifically, managers pool their various business, functional, and personal expertise to make the choices that shape the major strategic moves of the firm (Eisenhardt and Martin, 2000). Examples of strategic decision making include development of new markets, adoption of new business models etc.

1.2.6 Alliances and Networks

Alliances and networks management is a dynamic capability that is related to the acquisition of resources. Alliance and network routines bring new resources into the firm from external sources (Eisenhardt and Martin, 2000). Examples of alliances and networks include collaborative research and working with third-party developers. Table 2 shows the categorization of dynamic capabilities.

Figure 1. Building of dynamic capabilities. Modified from: Schilke, O (2013)[3]. Second-Order Dynamic Capabilities: How Do They Matter? Academy of Management Perspectives.

"Second-order dynamic capability is an organisation's increased capacity to sustain and build its capabilities"



[3] Schilke, O (2013): Second-Order Dynamic Capabilities: How Do They Matter? Academy of Management Perspectives

Table 2. Categorization of dynamic capabilities.

Dynamic capabilities	
New products or services	1. Design, testing, piloting of new products, processes, or services 2. Use of new innovations 3. Protection of intellectual property (for example, embodied in technology, patents, trademarks, components, platforms, or systems)
Strategic decision making	4. Addressing new product or service markets domestically 5. Addressing new product or service markets internationally 6. Evaluating and adopting new business models 7. Abandoning low performing, products, processes, services, units, or markets
Alliances and Networks (ecosystems)	8. Scanning and networking to stay abreast of technological or other change in the business environment 9. Scanning and networking to stay abreast of changes to industrial standards, regulations, or other conformance requirements 10. Research, development, or innovation (RDI) engagement with other actors (e.g. collaboration or contract RDI with other companies research institutes or universities) 11. Acquiring resources to support development of new products or services, or to support expansion 12. Working with third-parties to enhance products, processes, services, or overall organizational performance

1.3 Exploration *versus* Exploitation

March (1991) considers the relation between the exploration of new possibilities and the exploitation of old certainties in organizational learning. In literature of organizational learning, the problem of balancing exploration and exploitation is exhibited in distinctions made between refinement of an existing technology and invention of a new one (Levinthal and March, 1981; March, 1991). Both exploration and exploitation activities are essential for firms, but they also compete with each other for scarce resources (March, 1991). Therefore, firms need to maintain appropriate balance between their exploration and exploitation activities for successful organizational adaptation, technological innovation, organizational learning, and even organizational survival (Gupta et al., 2006).

The essence of exploitation is the refinement and extension of existing competences, technologies, and paradigms, with positive, proximate, and predictable returns; while the essence of exploration is experimentation with new alternatives, with uncertain, distant and often negative returns (March, 1991). Exploration includes things captured by terms such as search, variation, risk taking, experimentation, discovery, innovation, and creation; while exploitation includes such things as refinement, production, efficiency, selection, implementation, and execution (March, 1991). Table 3 presents the capabilities matrix that distinguishes between exploration and exploitation capabilities.

Main findings of Chapter 1

- There is a need to systematize the use of capability as a concept in future studies regarding monitoring and impact evaluation.
- The literature provides several different definitions for the concept of Capability, each equally valid for their own purpose (see also 2.2 below and the concept of behavioural additionality).
- Tekes has its own definition, which could be further elaborated and clarified. Emphasis should be paid particularly on the building of dynamic capabilities.
- For the above reasons, the literature does not provide an overall answer to the question on how public RDI funding and innovation activities improve capabilities.

Table 3. Capabilities matrix.

Capabilities Matrix	Exploration	Exploitation
Market and environment-related (including societal changes)	1. Engagement with potential customers and end users to gain an understanding of unmet market and societal needs	2. Market intelligence, and management of distribution channels 3. Promotion of corporate products, processes, or services
Information or operations-related	4. Evaluation and adoption of new knowledge, information, technology, products, processes, or services	5. The management of supplier networks 6. Increasing operational efficiencies
New products or services	7. Design, testing, piloting of new products, processes, or services	8. Use of new innovations 9. Protection of intellectual property (for example, embodied in technology, patents, trademarks, components, platforms, or systems)
Strategic decision making	10. Addressing new product or service markets domestically 11. Addressing new product or service markets internationally 12. Evaluating and adopting new business models	13. Abandoning low performing, products, processes, services, units, or markets
Alliances	14. Scanning and networking to stay abreast of technological or other change in the business environment 15. Scanning and networking to stay abreast of changes to industrial standards, regulations, or other conformance requirements 16. Research, development, or innovation (RDI) engagement with other actors (e.g. collaboration or contract RDI with other companies, research institutes, or universities)	17. Acquiring resources to support development of new products or services, or to support expansion 18. Working with third-parties to enhance products, processes, services, or overall organizational performance

Literature Review References

Augier, M., & Teece, D.J. (2009). Dynamic capabilities and the role of managers in business strategy and economic performance. *Organization Science*, 20 (2), 410–421.

Collis, D.J. (1994). Research note: how valuable are organizational capabilities? *Strategic Management Journal*, 15, 143–152.

Drnevich, P. L., & Kriauciunas, A. P. (2011). Clarifying the conditions and limits of the contributions of ordinary and dynamic capabilities to relative firm performance. *Strategic Management Journal*, 32(3), 254–279.

Eisenhardt, K.M., & Martin, J.A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21 (10–11), 1105–1121.

Gupta, A. K., Shalley, C. E., & Smith, K. G. (2006). The interplay between exploration and exploitation. *Academy of Management Journal*, 49(4), 693.

Helfat, C. E. (2007). Dynamic capabilities: Understanding strategic change in organizations. Malden, MA: Malden, MA: Blackwell Pub., 2007.

Helfat, C. E., & Raubitschek, R. S. (2000). Product sequencing: Co-evolution of knowledge, capabilities and products. *Strategic Management Journal*, 21(10), 961–979.

Helfat, C. E., & Winter, S. G. (2011). Untangling dynamic and operational capabilities: Strategy for the (N)ever-changing world. *Strategic Management Journal*, 32(11), 1243–1250.

Levinthal, D., & March, J. G. (1981). A model of adaptive organizational search. *Journal of Economic Behavior and Organization*, 2(4), 307–333.

March JG. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71–87.

Nelson, R. R. (1982). In Winter S. G. (Ed.), An evolutionary theory of economic change. Cambridge, Mass: Belknap Press of Harvard University Press, 1982.

Sapienza, H. J., Autio, E., George, G., & Zahra, S. A. (2006). A capabilities perspective on the effects of early internationalization on firm survival and growth. *The Academy of Management Review*, 31(4), 914–933.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350.

Teece, D. J. (2014). A dynamic capabilities- based entrepreneurial theory of the multinational enterprise. *Journal of International Business Studies*, 45(1), 8.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.

Winter, S. G. (2000). The satisficing principle in capability learning. *Strategic Management Journal*, 21(10), 981–996.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, 24(10), 991–995.

2 Framework and methodology

2.1 Impact study questions

The main goal was to produce a comprehensive impact study of Tekes' success in achieving the objectives associated with the target area of capabilities for innovation activities in research projects of large firms and research organisations and universities. The impact study questions in work packages A and B are shown in Table 4.

2.2 Framework

Our methodological approach to assessment of Tekes' impact on capabilities combined three essential viewpoints: a) the general impact model utilized by Tekes evaluations, b) the TEN impact assessment model with c) categorization of company capabilities (Wallin et al. 2012[4]) as shown in Table 5. Furthermore, our approach pays particular emphasis on the improvements to capabilities, for example, the impact of Tekes on improvements to business linkages (effect of networks) or impact of Tekes on improvements to knowledge or expertise (such as through research projects).

While it is possible to map the assessment dimensions of our approach to the categories of Wallin et al., it has been necessary to seek more specific insights on impact. For example, our assessment dimension 'Knowledge, expertise' refers to innovation support initiatives that lead to improvements in companies' knowledge or access to information. In turn, improvements to knowledge refer, for example, to

Table 4. Impact study questions.

Work Package A: Literature Review, interviews, indicators and case studies 1. What are the findings of international literature how public RDI funding and innovation activities in general improve capabilities? 2. How actors of the Finnish innovation environment have improved their capabilities in Tekes research projects? 3. What is the role of SMEs in these research portfolios? 4. What are the results and impacts after Tekes funding? 5. How large firms and research organizations and universities have answered to questions concerning the organization level impacts and Tekes intervention? 6. How the large firms and research organizations and universities have answered to question about innovation capabilities and broader impacts to the networks and the whole sector? (spillovers in other actors as well as society and economy)
Work package B: Tekes Strategy, Objectives and Impact Analysis When considering the results of Working Package A and logic of the impact assessment model, how the activities of Tekes have contributed to the building of innovation capabilities: 7. In what ways has Tekes influenced the generation of intellectual capital, capabilities and the development of intellectual investments in Finland? 8. How has Tekes succeeded in achieving its objectives associated with capabilities for innovation activities, competence bases, and internationalization and networking? 9. What types of methods for continuous monitoring, measurement and indicators can be identified for Tekes management to support capabilities for innovation activities? How should the criteria, instruments and operating methods be improved? 10. What are the future suggestions and recommendations how Tekes can improve its impact on capabilities? How results and impacts of Tekes funding should be measured more effectively by Tekes (when considering research organizations, universities and large firms)? 11. When considering capabilities and the current structural change in the Finnish economy, how capable to renew is the Finnish innovation sector in the current economic situation?

4 Wallin, J. (ed.), Cooke, P., Eriksson, A., Laamannen, T. & Laxell, P. 2012. Capabilities for innvoation activities. Impact study. Tekes Review 291/2012.

Table 5. Framework.

	Relationship capability	Transformative capability	Integrative capability	Generative capability	Culturing capability	Business modeling capability	Coordiation capability
Knowledge, expertise		Offering design		Innovation		Absorptive capacity	
Promotion	Customer intelligence				Socialization		
Business linkages	Customer linking		External integration				
Research linkages				Innovation			
Technology capabilities				Execution			
Financial capabilities						Conceptualisation	
Complimentary business capabilities			Internal integration		Rule modeling	Conceptualisation, Timing	Change mgt, Internal coord., Constellation mgt

business, technical, market, or other knowledge. Improved access to new information refers, for example, to access to research papers, technical reports, standards or regulatory information, or community news. In a similar fashion, networks and linkages are far more pervasive in terms of impact than 'customer intelligence' and 'customer' linking'. Our Business linkages dimension, for example, will be used to assess the impact of Tekes on facilitation of relationships with customers, suppliers, partners, or other companies that, for example, result in improved business capacity, access to new industrial knowledge, products, or services through exposure to large company product or service lines, or new channels to market. It is at this fine-grained level that we will mine the available literature, documents, and survey materials, as well as create ten case studies to describe the impact of Tekes on improvements to companies' capabilities.

In the foregoing we have shown how our logic model is used to assess the impact of innovation initiatives on companies. In the present context, we will use this model to identify impacts of Tekes on research projects of large firms, as well as the role of SME's.

To understand Tekes' impacts on research organizations and universities, we will also be guided by our logic model. Working backwards from the impact dimensions listed in our logic model (knowledge, promotion opportunities, business linkages, research linkages, technology capabilities, financing capabilities, complementary business capabilities) we will seek to answer the question: To what degree did universities or research organizations increase their capabilities and translate those capabilities (through networks, for example) to companies, benefitting the Finnish economy and society? For example, we will endeavor to determine the impact of Tekes funding on improvements to universities" technical capabilities, and the degree to which those capabilities were made available to increase the technical capabilities of companies (for example, through development of new networks). In other words, with reference to the logic model described above, we will determine the degree to which universities' activities were stimulated by Tekes, within the context of 'forerunning' or precursor activities on the path towards improving the capabilities of companies.

The TEN impact assessment model systematically links the Tekes impact model that is based upon the concepts of additionality to The Evidence Network's (TEN) impact assessment logic model shown below. TEN's logic model, which is designed specifically for innovation impact assessments, identifies improvements to companies' resources and capabilities (behavioural additionality), improvements to companies performance (output additionality), and socio-economic benefits that result from innovation support programs such as those of Tekes. It directly connects to the logic of Tekes' strategy and Tekes' impact model.

It is also noteworthy that the assessment dimensions (or measures) of this logic model (Knowledge, Business linkages, Technology capabilities, etc.) are also directly linked to the intellectual capital perspective described in Capabilities for innovation impact activities (Wallin et al. 2012) as shown in Table 6. There is one important difference, however. The work described in Wallin et al. identifies broad concepts pertinent to categorizing companies' capabilities, while the approach we will use is based upon assessment of improvements to capabilities (impact) due to Tekes. This distinction is important because our literature review, case studies,

Table 6. Link between the TEN Assessment Dimensions and categorization of capabilities by Wallin et al. (2012.

TEN Assessment Dimensions	From Wallin et al. (2012): Capabilities for innovation activities impact study		
	Human capital	**Structural capital**	**Relational capital**
Knowledge, expertise	x		
Promotion	x	x	
Business Linkages	x		x
Research Linkages	x		x
Technology Capabilities	x[3]	x	
Financial Capabilities	x	x	
Complementary Business Capabilities	x	x	x

statistical analyses, suggestions, and recommendations will be created using a proven methodology based upon Tekes' additionality or improvements to capabilities.

2.3 Summary of methodology

It should be noted that the study material was limited to Tekes funding for public research organizations and large companies. For example, funding instruments for young innovative firms and SMEs were out of scope. The impact study combined multiple research methods, which are summarized as follows.

- Literature review of literature concerning capabilities and other relevant material concerning Tekes. The desk study included the description of the definition of capability.
- Electronic survey. For the description of the TEN Methodology see Appendix D (see also 2.2 and 3.1). In an effort to assess the role of Tekes support on the capabilities of companies and research organizations, TEN and RMC developed a customized questionnaire for companies and a customized questionnaire for research organizations. The impact surveys were developed based on TEN's impact assessment methodology and were informed by an extensive literature review to determine specific impact measures applicable to both target groups. Fifteen capabilities measures were identified for companies, and 19 capabilities measures were identified for research organizations.
- Statistical analysis of Tekes "three years after" questionnaire. Data used in this study include research projects that have been ended during 2005–2011. Tekes gathers a data three years after the project has ended (see also 3.2).
- Case studies. The selection of case studies is presented below. The material included information from Tekes' monitoring system, interviews and documents provided by the interviewees.
- Validation workshop was organized on 7 January 2015 to present and test the preliminary findings and conclusions of the impact study. The participants of the validation workshop represented Tekes and the Ministry of Employment and the Economy.

Table 7. Selection of case studies.

Organization	Sector				
		ICT/electronics	Mechanical, metal and mine industry	Environment and energy	Well-being, food and health
	Listed domestic company	Teleste Oy	Ponsse Oy	Kemira Oy	
	Listed foreign company				Bayer
	Strategic research	Strategic Centre for Science, Technology and Innovation (SHOK) Digile, Data 2 Intelligence programme		Strategic opening NEO-CARBON ENERGY	Strategic opening Human Spare Parts

3 Results

3.1 Results of the electronic survey

The detailed report of the electronic survey is presented in Appendix 1. The Appendix provides also TEN's impact assessment methodology, details on the response profile of participant companies, examples of questions, additional 'other' responses, regression analysis model results, and a glossary of terms. The results of the survey are summarized in the present section. The full, in-depth regression analysis, with all of the regression models, is provided in Appendix J.

3.1.1 Company capabilities

3.1.1.1 Company information and company performance

The company information is presented in detail in the separate Appendix 1. It is important to note that the findings indicate that respondent companies are typically older and larger with headquarters in the Uusimaa region. Seventy-three percent (73%) of respondents were founded in 1982 or earlier and 60% of respondents employ 500 people or more. Further, 38% of respondents invest over €10 million in research, development, or innovation (RDI). This ability to invest large sums in RDI is in keeping with the age and size of most respondent companies, as older, larger companies have a greater capacity to make significant financial investments in areas such as RDI.

Despite the relative age and size of the respondent companies, 12% of respondents increased their annual revenues by more than 100%, and 18% of respondents increased their number of employees by 25% or more since having received support from Tekes. While these findings suggest that the respondent companies are experiencing modest growth, they are not considered high-growth companies. Thirty-five percent of companies report declining revenues and 48% report a decrease in the number of employees at their company since having received support from Tekes.

3.1.1.2 Importance of Capabilities for Companies

The table shows the 15 measures, and their associated examples, which were selected to assess companies' capabilities. A frequency distribution displaying the level of importance of each capability is shown below, followed by an analysis of findings including the number of respondents (n) for each capability assessed.

For all capabilities, the majority of respondents indicated that the capability was either of critical importance or was important to firms in their industry (Figure 2). This suggests that the capability measures selected to assess the impact of Tekes support on companies were appropriate and consistent with the needs of the companies analyzed.

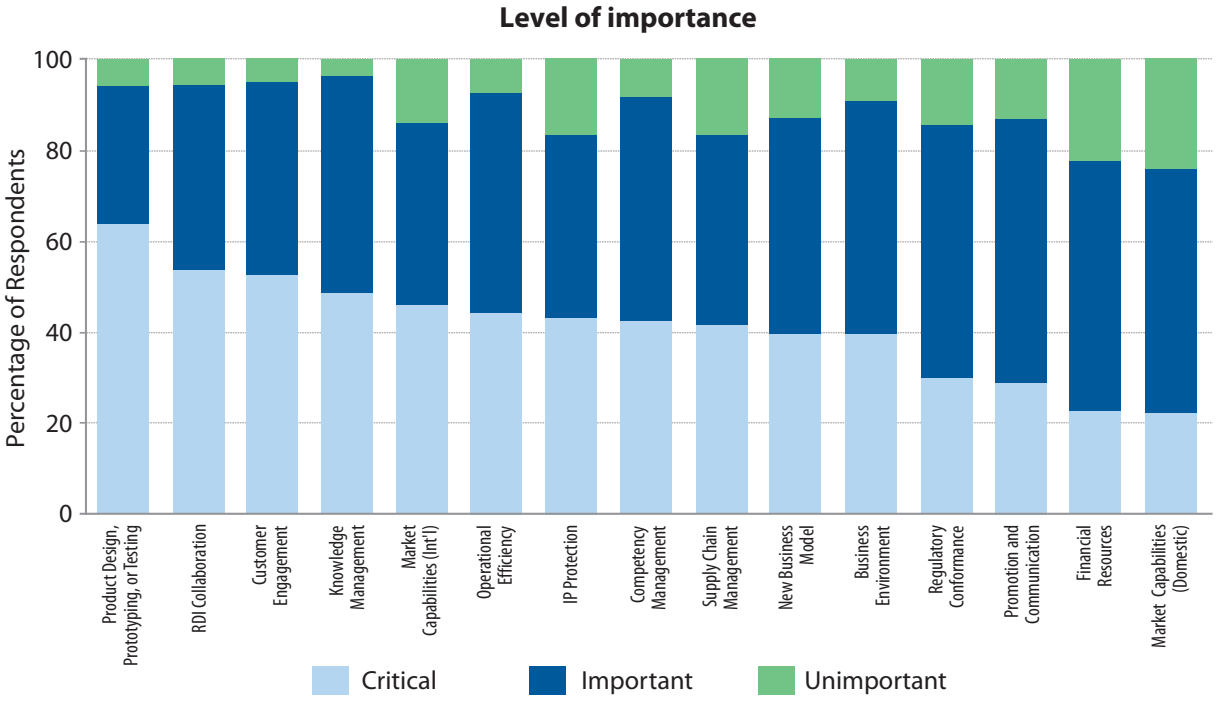
Product design, prototyping, or testing was identified as the capability of the greatest importance. Specifically, 64% of respondents reported that the ability to design, prototype, or test products is of critical importance to firms in their industry (Figure 2). This finding is in keeping with the interests of the large companies supported by Tekes, as the development of new products is one of the key criteria for their participation in Tekes programs.

As shown in Figure 2, domestic market capabilities were found to be the least critical in terms of importance to firms in their industry, while still having some level of importance to the majority of respondents. This may be, in part, due to the larger, older nature of the respondent companies, which have saturated the Finnish market and are now expanding into international markets looking for growth opportunities. Companies such as these would value the ability to analyze the Finnish market to a lesser degree compared to, for example, younger, smaller companies.

Table 8. Capabilities measures.

Capabilities Measure	Examples
Product design, prototyping, or testing	Design, test, or pilot new products, processes, or services, through the use of specialized equipment, software, technology, etc.
Customer engagement	Connecting with existing or potential customers and end users to elicit information or feedback on how your company's products, processes, or services can be improved to address unmet market or societal needs.
RDI collaboration	Capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.
Knowledge management	The management of new knowledge or information related to, for example, technology, products, processes, or services hat helps to accelerate your company's strategies.
Market capabilities (international)	Gathering intelligence (such as market studies, e.g. with other Team Finland partners) relevant to your company's markets outside Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Operational efficiency	Improvements to the efficiency of your organization's human resources, fixed assets or service acquisitions, financial investments, process-related, or other business practices.
Intellectual property protection	To ensure the protection or management of intellectual property, such as the use of patents, industrial design rights, trademarks, copyrights, process innovations, trade secrets, or rapid product creation and deployment, etc.
Competency management and development	Acquiring and retaining human resources (i.e. hiring new employees), developing and managing existing competences, utilizing external competences, etc.
Supply chain management	The design, planning, execution, control, or monitoring of supply chain activities with the objective of creating added value, building a competitive infrastructure, and leveraging logistics, while managing the flow of goods and services through your supplier networks.
New business model	Evaluate, develop, test, or adopt new business models to augment or change your company's value proposition, transform your revenue- generating model, improve cash flow, etc.
Business environment	Scanning (assembling information), or networking with industry professionals, customers, suppliers, partners, industry associations, etc. to stay abreast of technological changes, customers' needs or requirements, new methods or processes, trends, or other changes in your company's business environment.
Regulatory conformance	Capabilities to stay abreast of industrial standards, regulations, laws or legislation, or other conformance requirements.
Promotion and communication	The capacity to increase visibility or raise awareness of your company's products, processes, or services (e.g. digital marketing, participating at networking or partner events, media outreach, etc.).
Market capabilities (domestic)	Gathering intelligence (such as market studies etc.) relevant to your company's markets within Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Financial resources	Capabilities to raise capital through public or private sources, or secure investments in equipment or technology to support, for example, the development of new products, processes, services, or market expansion, etc.

Figure 2. To what degree is (capability) important for firms in your industry?



3.1.1.3 Change in Capabilities for Companies

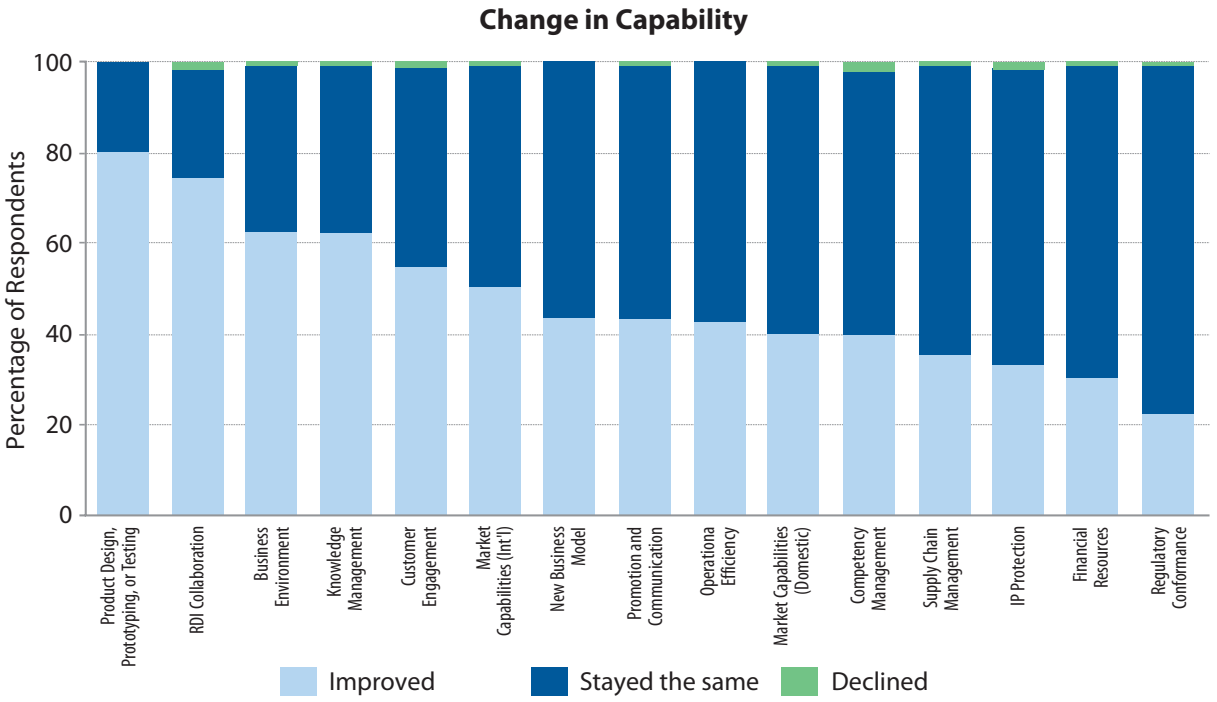
Building on the findings from the previous section, once it had been determined that a given capability was important, and therefore relevant, to respondents, they were asked to indicate their company's improvement in that capability since receiving Tekes support.

For all capabilities, the majority of respondents indicated that their company's ability either improved or stayed the same, while very few respondents indicated a decline in their capacity to perform for any capability measure (Figure 3).

Product design, prototyping, or testing capability was identified as the capability for which the greatest change was reported. Specifically, 81% of respondents reported that their company's ability to design, prototype, or test products has improved since receiving Tekes support. Regulatory conformance was found to be the capability for which the fewest respondents reported improvement since having received Tekes support (Figure 3). This is likely the result of selection bias, as companies that receive funding and support from Tekes go through a rigorous selection process, and only companies that are already abiding by their industry's regulations are accepted. Therefore we expect to see the majority of these companies remain the same with respect to their ability to conform to regulation.

Similarly, it is unsurprising that the Financial resources capability ranks relatively low in terms of improvement and relatively high in terms of staying the same. Given that most of the respondents represent large companies with existing streams of revenue, it would be unlikely that these companies would focus their energies on improving their ability to raise capital.

Figure 3. Since receiving Tekes support, how have your company's (capability) changed?



3.1.1.4 Source of Change in Capabilities for Companies

This section provides information on the sources of change for each of the 15 capabilities measures, as identified by the respondent companies. The following table shows the six improvement mechanisms, and their associated description, that were selected as sources of change for company capabilities.

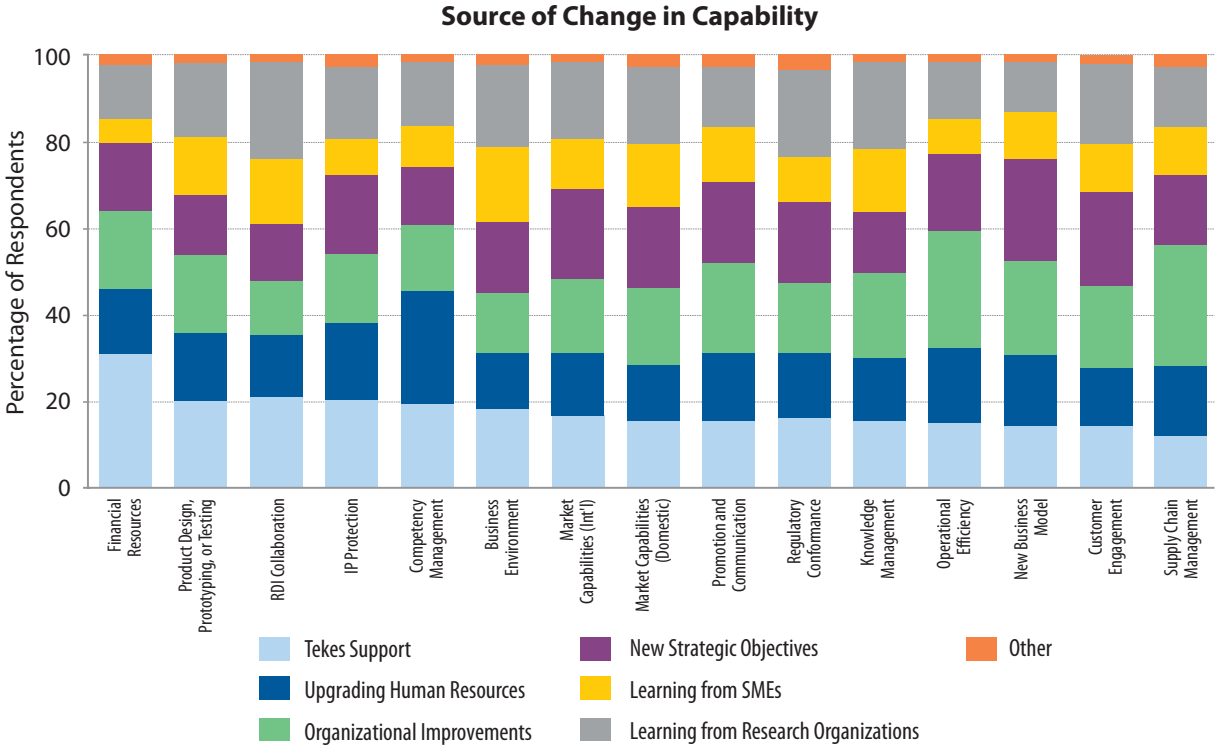
Seventy six percent of respondents reported that the Tekes support received led, in part, to their company's improvement in their *Financial resources* capability (Figure 4). Conversely, the Tekes support received had the least impact on companies' improvements to their *Supply chain management* capabilities.

A further exploration of the *Financial resources* capability yields interesting results. From the two previous sections, we find that the ability to raise capital or secure investment was reported to be of low importance, and that the improvement in this capability since having received support from Tekes was also low. However, we find that the greatest percentage of companies identified Tekes support as the mechanism for improvement of their *Financial resources* capability when this ability did indeed improve. Further, the regression analysis provided in Appendix J indicates that companies that reported the *Financial resources* capability to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. This exploration of the *Financial resources* capability suggests

Table 9. Improvement mechanisms.

Improvement Mechanism	Explanation
Tekes support (financial and non-financial)	Funding and business support provided by Tekes.
Upgrading human resources	Improved in-house expertise or improved ability to leverage external expertise.
Organizational improvements	New organizational processes, equipment, or infrastructure.
New strategic objectives	Pursuit of new strategic objectives that required new capabilities.
Learning from SMEs	Insights and capabilities gained from engaging with small and medium enterprises (SMEs)
Learning from research organizations	Insights and capabilities gained from engaging with research organizations.

Figure 4. Which of the following led to improvements in your company's (capability)? Please select all that apply.[5, 6] Respondents that identified 'Other' sources of change were given the opportunity to provide a literal response. These responses may be found in Appendix H.



that Tekes is considered by respondent companies to have the greatest impact on improvements to this capability that is among the least important for firms, and for which the fewest companies report improvement.

The *Product design, prototyping, or testing* capability was identified in the two previous sections as the capability of greatest importance, and the capability for which the greatest number of companies experienced improvement since receiving Tekes support. Furthermore, the regression analysis found that companies that reported the *Product design, prototyping, or testing* capability to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. In keeping with these findings, in this section we found that 65% of respondent companies reported that the Tekes support received had an impact on their company's ability to design, prototype, or test products (Figure 4).

In the section on capability improvement, the *Domestic market* capability was reported to be in the mid-range of the capabilities that were improved by companies. However, a noteworthy finding emerges from the regression analysis. This analysis indicated that the Tekes funding and business support provided are significant but negative predictors of improvements to company *Domestic market* capabilities, meaning that as funding and support increases, the improvements to this capability decreases.

Overall, we find that when companies indicated a capability was important for firms in their industry, and that they had experienced improvement in the specific capability measure, that the Tekes support is having a meaningful impact and is an important mechanism for improving their capacity to perform.

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5 Respondents that identified 'Other' sources of change were given the opportunity to provide a literal response. These responses may be found in Appendix H.

6 Respondents were invited to select all sources of change that applied to their company; this results in a greater number of responses than respondents for each question. As such, the frequency distribution presents the source of change findings as percentage of responses. However, the descriptive findings that follow are more meaningful when presented as percentage of respondents rather than responses. So while the frequency distribution and the descriptive findings do not align, they are both the clearest possible representations of the data.

3.1.1.5 Impact of Improvement Mechanisms on Company Capabilities

This section provides an overview of the impact of the six mechanisms on the overall improvement to companies' capabilities.[7] Respondents were asked to indicate the impact of each of the six improvement mechanisms on their company's overall capabilities. Details on our standardized question format are provided in Appendix F.

Reading clockwise in the following figure, the average impacts of the improvement mechanisms range from the high-end of 'significant impact' on improvements resulting from *Tekes support* to the low-end of 'significant impact' on improvements resulting from *Learning from SMEs* (Figure 5). Although, as we see in the regression analysis found in Appendix J, Tekes support did not emerge frequently as a predictor of improvement for company capabilities, when examined separately, 97% percent of respondents reported that the support they received from Tekes had a positive impact on their company's overall capabilities improvements.

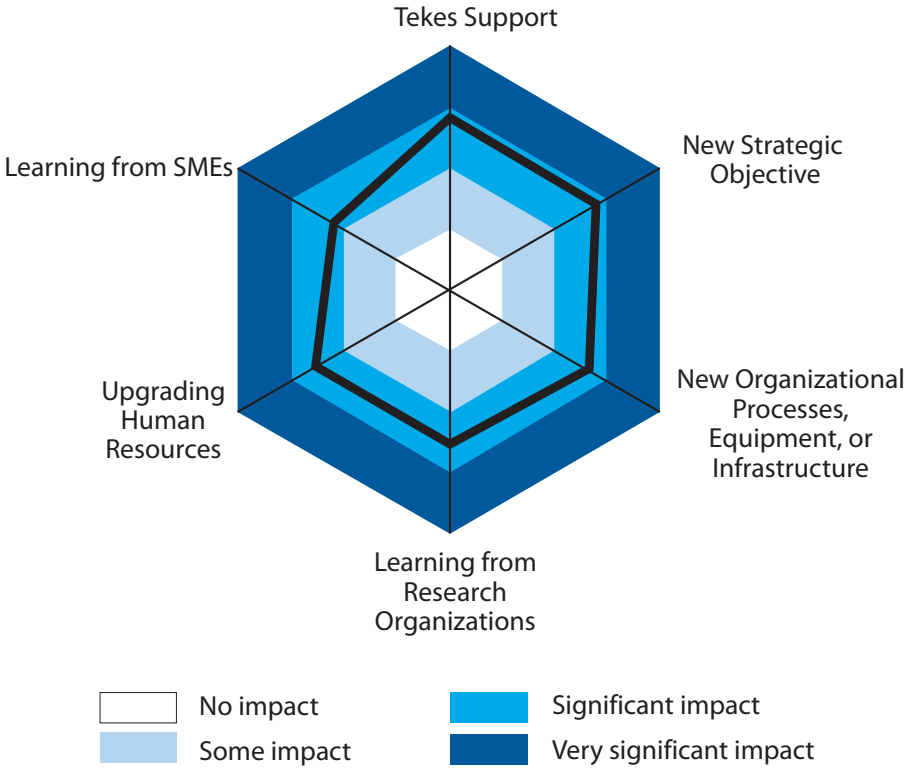
Additionally, the impact attributed to the *Tekes support* mechanism was higher than the impact attributed to all other improvement mechanisms, except for the setting of a *New strategic objective* measure (significant at least at the 95% confidence level) (Figure 5).

3.1.1.6 Company Engagement

This section provides information on the degree of engagement of respondent companies with small and medium enterprises (SMEs), as well as their engagement with research organizations, that was consequent to Tekes support. Figure 6 shows that 76% of companies reported that they engaged with SMEs to a 'moderate' or 'high' degree as a consequence of Tekes support, whereas 81% of companies reported that they engaged with research organizations to a 'moderate' or 'high' degree as a consequence of Tekes support (Figure 7).

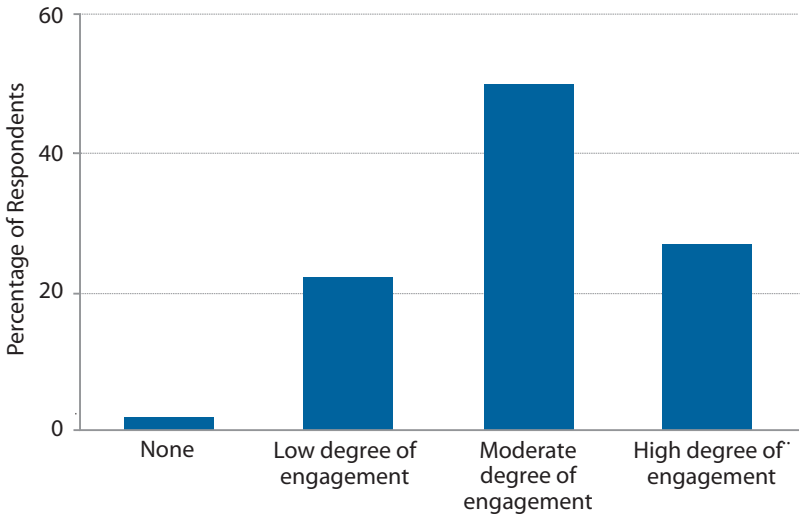
In keeping with Tekes' emphasis on collaboration, engagement with both small and medium enterprises (SMEs) and research organizations is one of the key criteria for

Figure 5. Average Impact of the Improvement Mechanisms on Companies' Overall Capabilities.



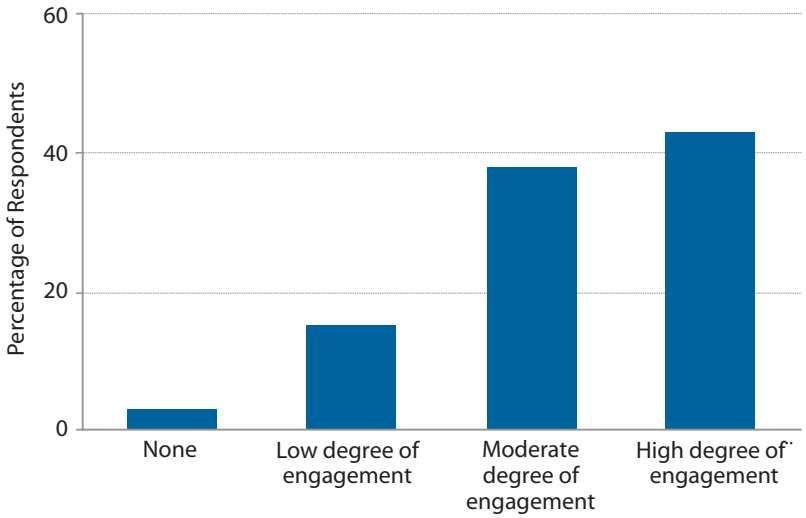
[7] Impact is measured on a scale using the following weights: 'No impact' 2.5, 'Some impact' 5.0, 'Significant impact' 7.5, 'Very significant impact' 10.0.

Figure 6. Engagement with SMEs.



Since your first engagement with Tekes, to what degree has your company engaged with SMEs as a consequence of Tekes support?
n=199

Figure 7. Engagement with research organizations.



Since your first engagement with Tekes, to what degree has your company engaged with research organizations as a consequence of Tekes support?
n=194

large companies to receive Tekes funding and support. The co-operation between higher education institutions, research institutes, and companies creates expertise in Finland, and in turn keeps innovation activities of companies in the country. Large-scale global challenges also require the collaboration of large companies and their networks with SMEs.[8] For certain capabilities, these engagements emerge as predictors of improvement, found in the regression findings in Appendix J, meaning that the greater the degree of engagement, the greater the improvement on the capability.

These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of companies, and further bolsters the need for continued engagement with SMEs and research organizations.

8 Taken from Tekes' Invitation to tender on the procurement of The Impact of Tekes Activities on Capabilities.

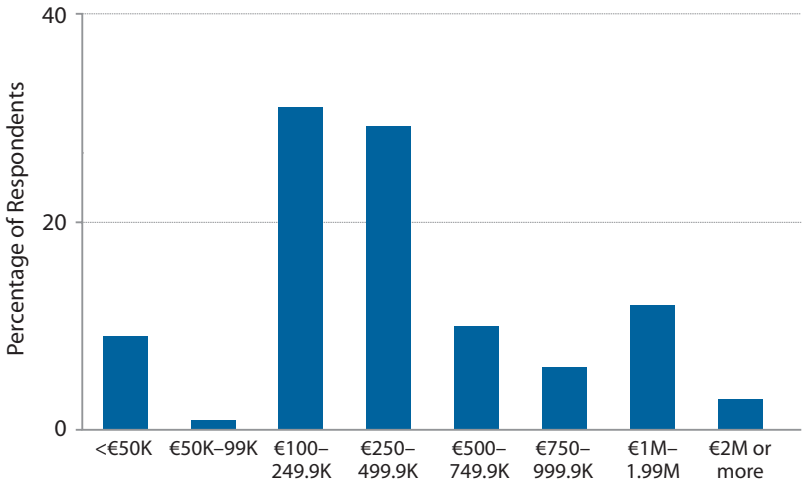
3.1.1.7 Company Investment Allocations and Rationale

This section provides an overview of the amount of financial support received, investment decisions, and the allocation of funding for specific business functions. While all respondents received funding from Tekes, the amount of funding received varies greatly depending on the scope of the funded project. As shown in Figure 8, *74% of companies received less than €500K in funding from Tekes*. However, the regression analysis, found in Appendix J, indicates that the amount of funding provided by Tekes is only predictive of improvements in the ability of companies to operate efficiently. For all other capabilities measures, the amount of funding does not emerge as a significant variable explaining improvements.

Further, respondents invested in people and external services to the greatest degree (Figure 9), while only 26% of respondents invested the Tekes funding received in equipment or technology (Figure 11). *Instead,* 81% of respondents reported that their company invested in external services to a 'moderate' or 'high' degree (Figure 10*)*. Only 5% of respondents reported that their company invested in other areas of their business to a 'moderate' or 'high' degree.

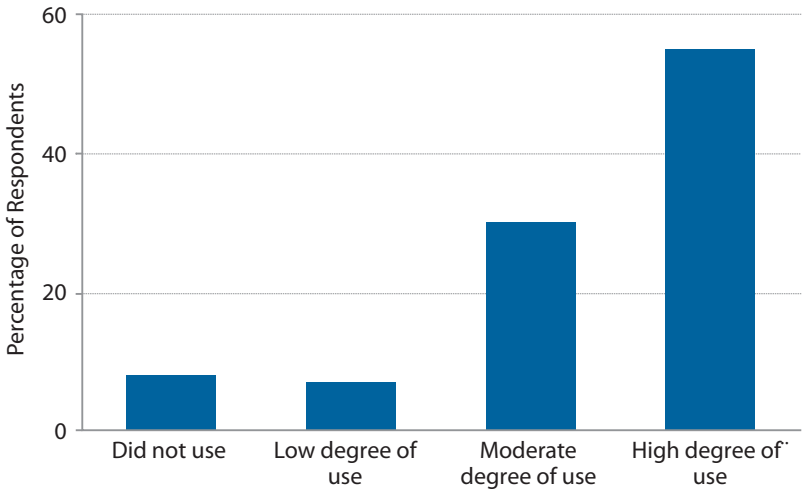
However, 87% of respondents cited product or service development as part of the rationale for their investment decisions (Figure 12). This suggests that for the respondent companies, which are typically larger and older companies, human capital is more critical than improvements to equipment or technology for the development of innovative products or services.

Figure 8. Amount of funding.



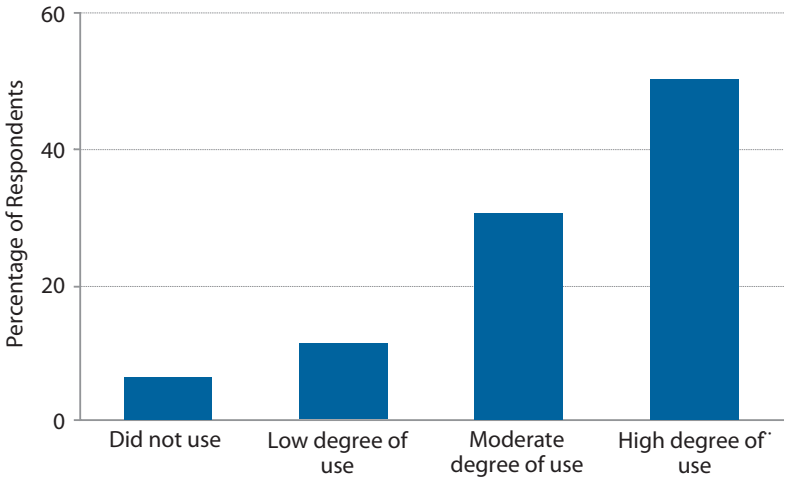
What is the value of funding your company has received from Tekes?
n=205

Figure 9. Investment in people.



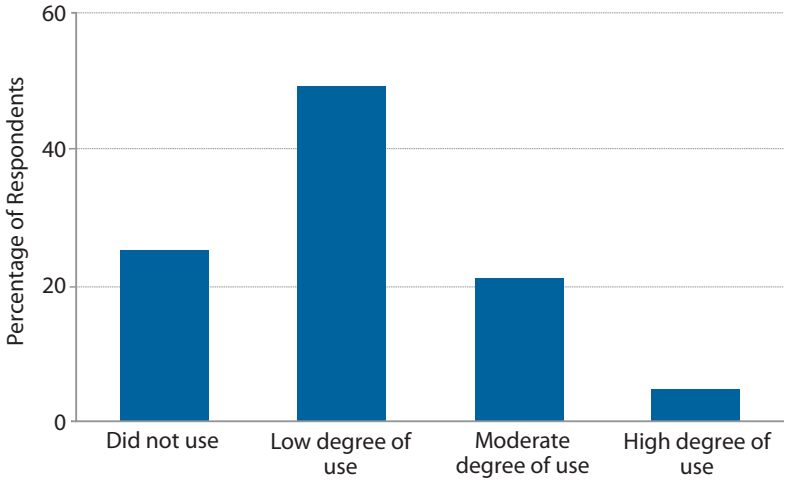
Investment in people.
n=195

Figure 10. Investment in external services.



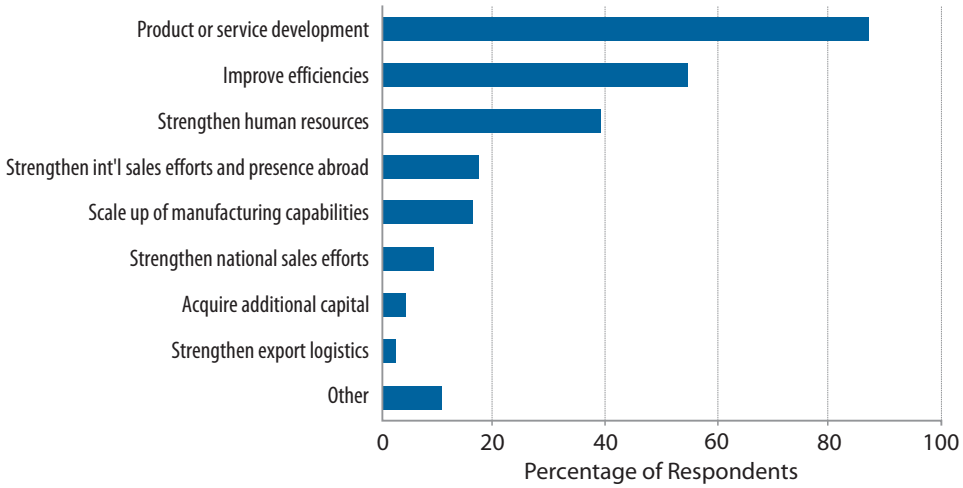
Investment in external services.
n=196

Figure 11. Investment in equipment or technology.



Investment in equipment or technology.
n=185

Figure 12. Internal distribution of Tekes funding.



Please identify why your company utilized the money provided by Tekes, in the areas selected in the previous question.[9]
n=196[10]

[9] Respondents that identified 'Other' investment rationales were given the opportunity to provide a literal response. These responses may be found in Appendix H.

[10] Respondents were invited to select all that applied. As a result the percentages may not add to 100.

3.1.2 Research institute capabilities

It should be noted that the terminology 'research organizations' may refer to individual researchers, a university representative, or a research organization that has been engaged with Tekes and received support (Appendix 1).

3.1.2.1 Importance of Capabilities for Research Organizations

The research organization capabilities were divided into three groups based upon the findings in the literature review: 1) Strategic direction 2) Alliances and, and 3) Projects and performance of research (Tables 10–12).

Table 10. Strategic direction capabilities measures.

Strategic Direction Capabilities Measures	Examples
Access to research funding	Capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.
Identify relevant research	Capabilities for the identification of scientific or technological disciplines, business sectors, or community or social imperatives that may determine the focus of individual or organizational research projects relevant to business, and more generally to society.
Design research projects	Capabilities that ensure effective linkages between strategic research directions, research plans, and resource deployment so as to optimize research productivity, such as establishment of realistic expectations in research plans, ensuring harmony between research plans and available personnel and equipment, and effective use of milestones.
International journal publications	Access to leading journals based upon peer review of the quality of research.
Attract highly qualified personnel (HQP)	Planning for and management of research, technical, and other supporting personnel to ensure that optimal competencies are available for the conduct of research, present and future, such as competency audits in relation to strategic priorities, and effective recruitment and human resource practices.
New research models	Capabilities to evaluate or develop new models for the conduct of research, for example, strategic focus on national priorities, increasing the use of multidisciplinary teams, user-pay models, or new strategies to select partners, clients, or funders.
Access to experiment resources	Capabilities include access to laboratories, specialized equipment, facilities, or data to support research investigations, creation of prototypes, new compounds, facilities for piloting and scale-up, whether directly available to researchers in organizations or secured from external sources.
Influence international research	Invitations to participate in strategic research deliberations in international forums, participation in international symposia, or provision of expert advice on research matters of international importance.

Table 11. Alliances and networks capabilities measures.

Alliances and Networks Capabilities Measure	Examples
International research participation	Capabilities to participate in international research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
Conduct research with companies	Capabilities to collaborate with companies or representatives of companies in projects, consortia, contract research, or other means by which collaborative RDI is undertaken.
National research participation	Capabilities to participate in domestic research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
National research leadership	Initiatives to create or lead new national networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.
International research leadership	Initiatives to create or lead new international networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.

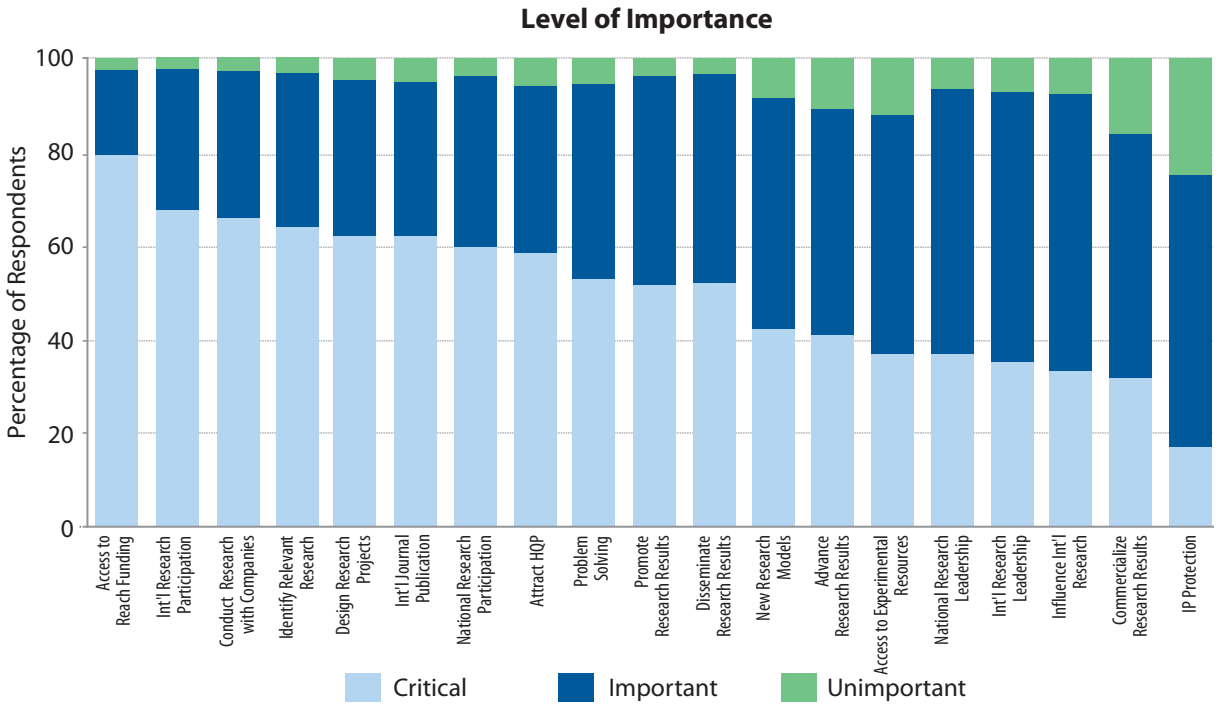
Table 12. Projects and performance of research capabilities measures.

Projects and Performance of Research Capabilities Measures	Examples
Problem solving	Capabilities include those to validate ideas, assess industrial designs, process, or production issues, for example, through access to technical documents or broader literature, on-site consultations, and use of know-how.
Promote research results	Capabilities include the capacity to increase visibility or raise awareness of your RDI (research, development or innovation) capabilities, such as through presentations, reports, media outreach, networking events, etc.
Disseminate research results	Capabilities to make research more assessable to individuals, businesses, or communities, such as innovative intellectual property policies, public forums on research findings, schemes to improve spill-over access to findings by competitors, and creative involvement of public institutions to foster both procurement of research-intensive products or services, or provide greater visibility to publically funded research.
Advance research results	Capabilities include knowledge that enables creation of new research ideas, use of tools and techniques for their validation, development of prototypes, knowledge of testing protocols, ability to move from laboratory to larger scales (idea development to new or improved products or services).
Commercialize research results	Capabilities to foster the use of research such as forging research-user relationships for the identification, development, conduct, or deployment of products and services from research projects, syndicating investment in research projects by multiple end-users, or use of personnel who can articulate the benefits of complex research undertakings to less-specialized users.
Intellectual property protection	Capabilities include the identification of potentially valuable intellectual property, to ensure its protection through the use of patents, publications, documentation of know-how, or capabilities to disseminate intellectual property for use through licensing or other methods.

Overall, the majority of respondents indicated that the capabilities analyzed were either of critical importance or were important to their organization. *Access to research funding* was identified by respondents as the most critical capability. Specifically, 80% of respondents reported that *Access to research funding* was of critical importance to their organization. Unlike the majority of the companies surveyed in Part 1 of this report, the research organizations surveyed in Part 2 do not generate substantial revenue that can be allocated towards research and development activities. As such, these organizations constantly seek other sources of financing to advance their research efforts, which leads to the elevated importance in the ability to leverage internal and external funding for the purposes of research. *Intellectual property protection* was found to be the least critically important capability for research organizations (Figure 13).

Among the alliances and networks capabilities, *International research participation* was identified as the most critical. Finally, of the projects and performance of research capabilities, *Problem solving* was deemed to be the most critical. However, it should be noted that as a group of capabilities, respondents deemed the projects and performance of research capabilities to be the least important for their organizations.

Figure 13. To what degree is (capability) important for your organization?



3.1.2.2 Change in Capabilities for Research Organizations

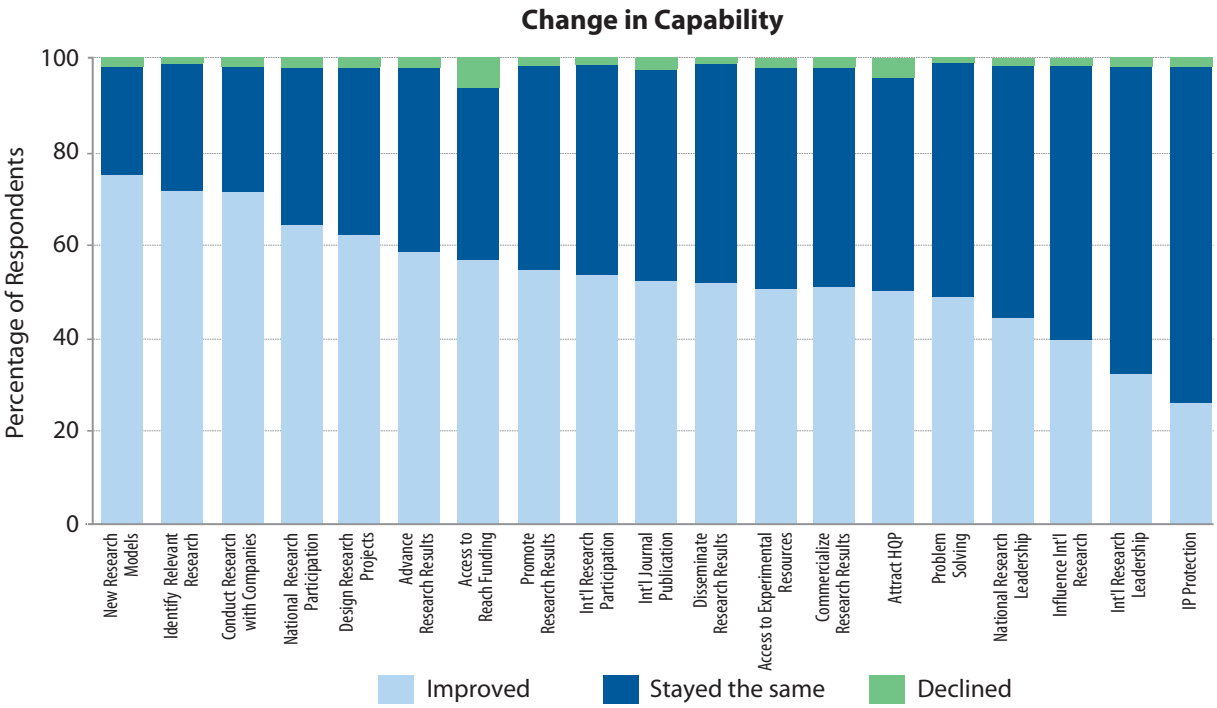
This section provides information on the change experienced by respondent organizations for each of the 19 capabilities measures, as identified by the respondent organizations (Figure 14). Overall, for the majority of capabilities measures, respondents indicated that their organization's capacity to perform either improved or stayed the same since receiving Tekes support.

The *New research models* capability was identified by organizations as the capability for which they experienced the greatest change. Specifically, 76% of respondents reported that their organization's ability to evaluate or develop new research models has improved since receiving Tekes support (Figure 14).

In keeping with the findings from the previous section, *Intellectual property protection* was found to be the capability for which the fewest respondents reported improvement, and for which the greatest number of respondents indicated their abilities have remained the same, since received Tekes support (Figure 14). This consistency is not surprising as the vast majority of respondents represent universities and research organizations, which would have experience and a wealth of knowledge pertaining to intellectual property protection prior to their engagement with Tekes.

Despite *Access to research funding* as having been identified in the previous section as the most critical capability of research organizations, respondents reported that they experienced the greatest decline in this capability since receiving Tekes support (Figure 14). While it was not expected for all respondents to report improvements in every capability, it was also not expected that research organizations would experience the greatest decline in the capability identified as the most important.

Figure 14. Since receiving Tekes support, how has your organization's (capability) changed?



3.1.2.3 Source of Change in Capabilities for Research Organizations

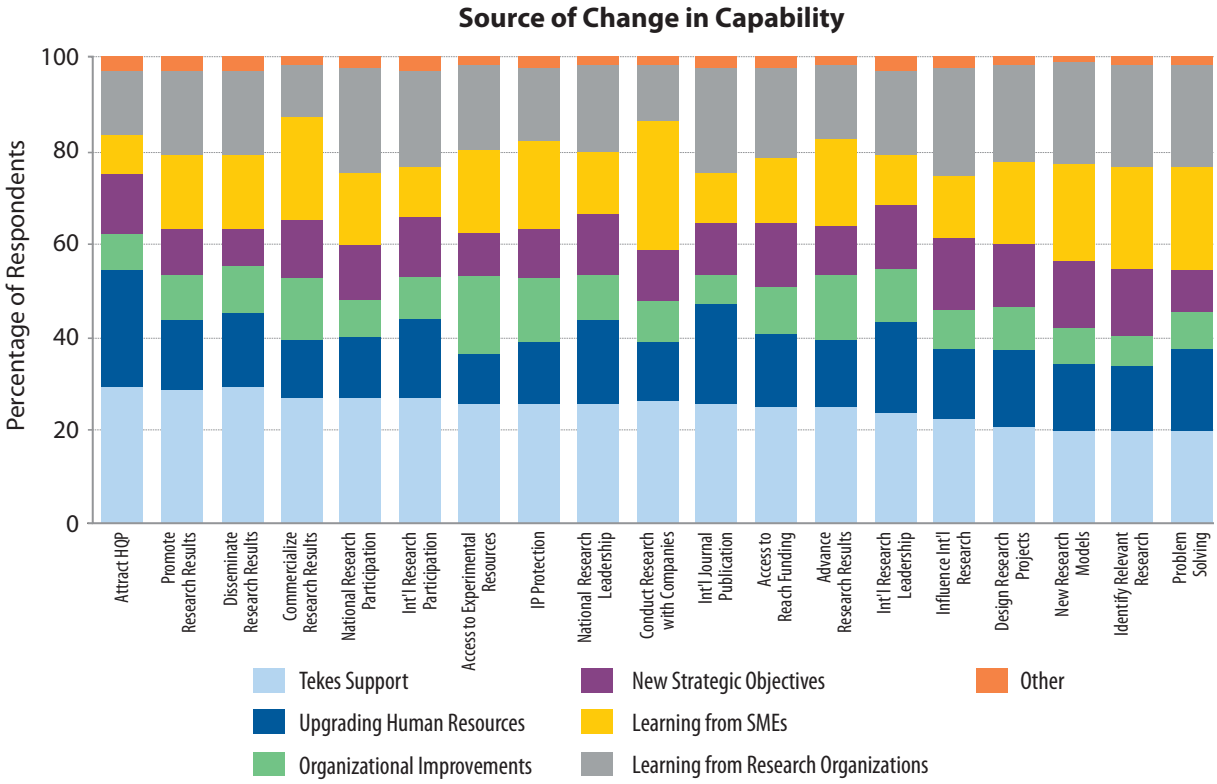
This section provides information on the sources of change for each of the 19 capabilities measures, as identified by the respondent organizations. The following table shows the six improvement mechanisms, and their associated description, that were selected as sources of change for research organization capabilities.

Tekes support was consistently identified by respondents as a source of change for all capabilities; for each capability, between 63% and 80% of respondents identified that Tekes support led, in part, to their improved capacity to perform (Figure 15). Additionally, and perhaps more importantly, the regression analysis found in Appendix J indicates that Tekes support, both financial and non-financial, predicts improvements in all capabilities. This means the

Table 13. Improvement mechanisms.

Improvement Mechanism	Examples
Tekes support (financial and non-financial)	Funding and business support provided by Tekes.
Upgrading human resources	Improved in-house expertise or improved ability to leverage external expertise.
Organizational improvements	New organizational processes, equipment, or infrastructure.
New strategic objectives	Pursuit of new strategic objectives that required new capabilities.
Learning from companies	Insights and capabilities gained from engaging with companies.
Learning from other research organizations	Insights and capabilities gained from engaging with other research organizations.

Figure 15. Which of the following led to improvements in your organization's (capability)? Please select all that apply.[11, 12]



more support that organizations receive from Tekes, either financial or non-financial, the more their capabilities or capacity to perform will improve.

Eighty percent of respondents reported that the Tekes support led, in part, to their organization's improved ability to collaborate with companies on research projects. Conversely, only 63% of respondents identified Tekes support as a source of change for their organization's improved ability to problem solve (Figure 15).

Further, in our previous analysis we found that respondents identified *Access to research funding* as the most critically important capability for their organization. From the regression analysis we find that organizations reporting *Access to research funding* to be of greater importance, attributed greater impact to Tekes on their ability to improve this capability. As well, organizations that identified *Access to research funding* as being important were more likely to identify Tekes as the source of their improvement in this capability. This explains why, of the respondents that identified *Access to research funding* to be important and also experienced improvement in this capability, 76% reported that it was the Tekes support received which led, in part, to their organization's improved ability to access internal or external research funding.

3.1.2.4 Impact of Improvement Mechanisms on Capabilities for Research Organizations

This section provides an overview of the impact of the seven mechanisms on the overall improvement to organizations' capabilities.[13] Respondents were asked to indicate the impact of each of the seven improvement mechanisms on their organization's overall capabilities.[14] Details on our standardized question format are provided in Appendix G.

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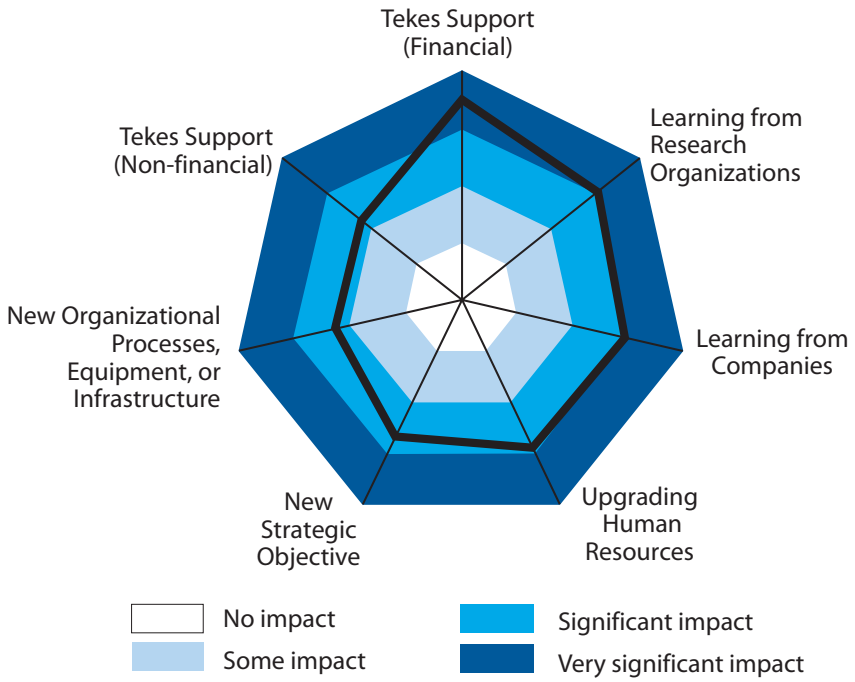
11 Respondents that identified 'Other' sources of change were given the opportunity to provide a literal response. These responses may be found in Appendix I.

12 Respondents were invited to select all sources of change that applied to their research organization; this results in a greater number of responses than respondents for each question. As such, the frequency distribution presents the source of change findings as percentage of responses. However, the descriptive findings that follow are more meaningful when presented as percentage of respondents rather than responses. So while the frequency distribution and the descriptive findings do not align, they are both the clearest possible representations of the data.

13 Impact is measured on a scale using the following weights: 'No impact' 2.5, 'Some impact' 5.0, 'Significant impact' 7.5, 'Very significant impact' 10.0.

14 To determine the impact of the mechanisms on improving organization's overall capabilities, Tekes support was split into financial and non-financial support, with respondents having the choice to select one or the other, as well as both.

Figure 16. Average Impact of the Improvement Mechanisms on Organizations' Overall Capabilities. Reading clockwise in the figure, the average impacts of the improvement mechanisms range from the middle of 'very significant impact' for the Tekes financial support mechanism to the low-end of the 'significant impact' range for the Tekes non-financial support mechanism.

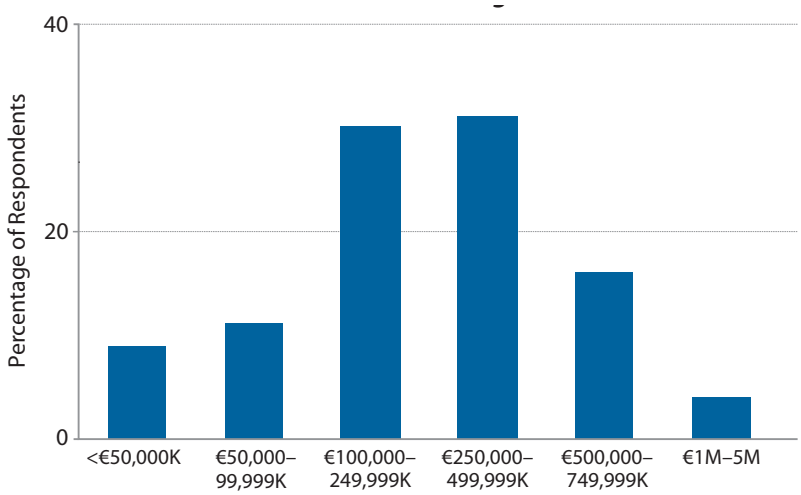


Ninety-nine percent of respondents reported that the financial support received from Tekes had a positive impact on improving their capabilities, their overall capacity to perform. The findings indicate that the impact attributed to the *Tekes financial support* mechanism was higher than the impacts attributed to all other improvement mechanisms. Additionally, the Tekes non-financial support was deemed by respondents to have the least impact on improving their overall capacity to perform (Figure 16).

3.1.2.5 Funding for Research Organizations

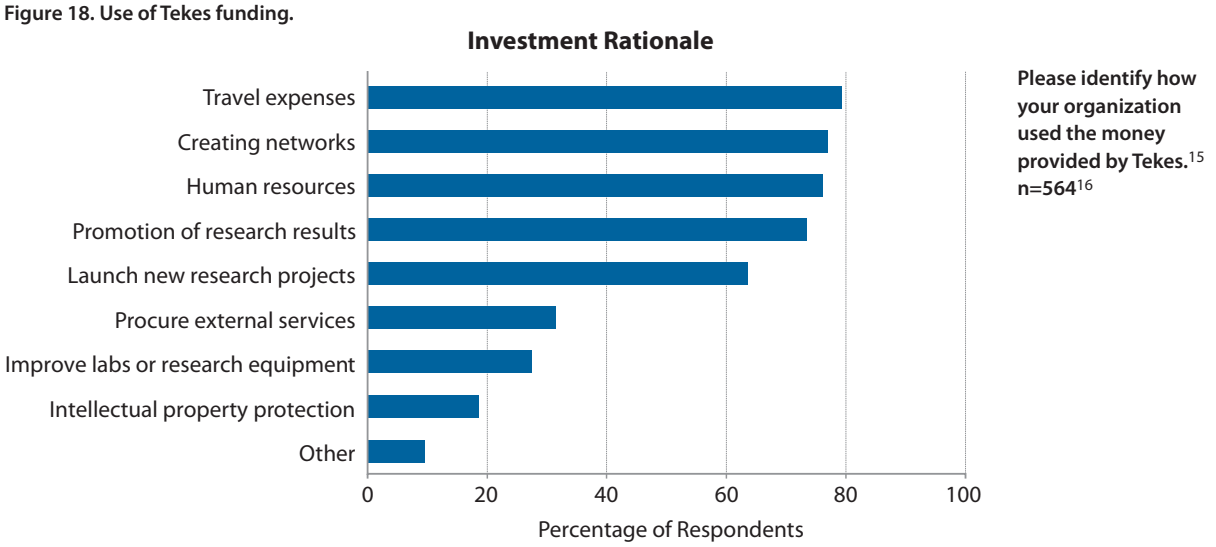
This section provides an overview of the amount of financial support provided by Tekes, and the investment rationale of the research organizations. Approximately *31% of organizations received between €250K and €499K in funding from Tekes* (Figure 17). The greatest number of respondents indicated that the Tekes funding was allocated to cover travel expenses, followed closely by the number of respondents that indicated the Tekes funding was, in part, used to create networks (Figure 18).

Figure 17. Value of Tekes funding.



What is the value of funding your organization has received from Tekes? n=583

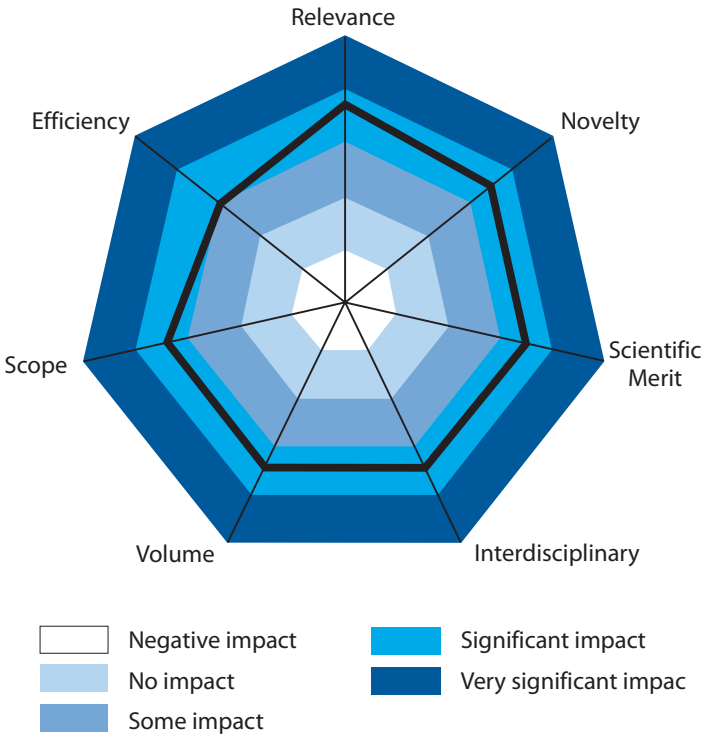
Figure 18. Use of Tekes funding.



3.1.2.6 Impact of Funding on Capabilities for Research Organizations

The capability improvements, which were made possible by Tekes funding, had significant positive impacts on organizations' overall research performance. Specifically, 97% of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on their organization's ability to engage in relevant research (Figure 19).

Figure 19. Average Impact of the Improvements to Organizations' Capabilities on Organizations' Research Performance. Reading clockwise in the figure, the average impacts of the improvements to organizations' capabilities range from the high-end of 'significant impact' on organizations' ability to engage in relevant research to the low-end of the 'significant impact' range on organizations' ability to improve research efficiency.



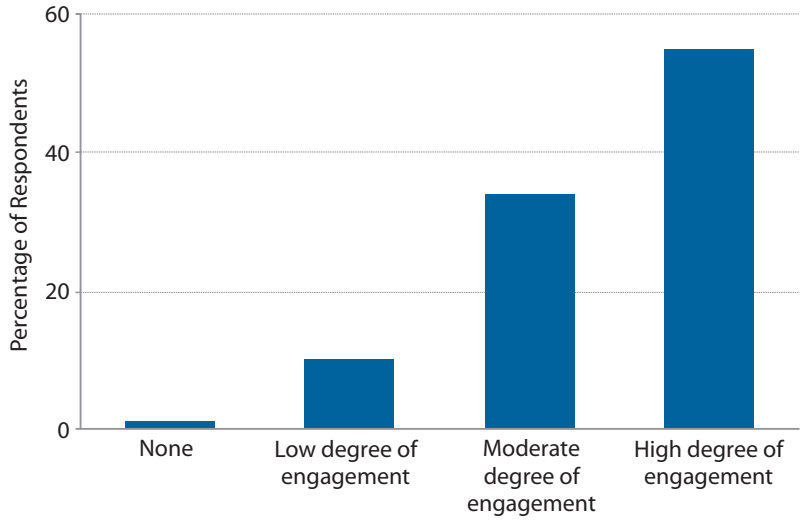
[15] Respondents that identified 'Other' rationales for investment were given the opportunity to provide a literal response. These responses may be found in Appendix I.

[16] Respondents were invited to select all that applied. As a result the percentages do not add to 100.

3.1.2.7 Engagement of Research Organizations

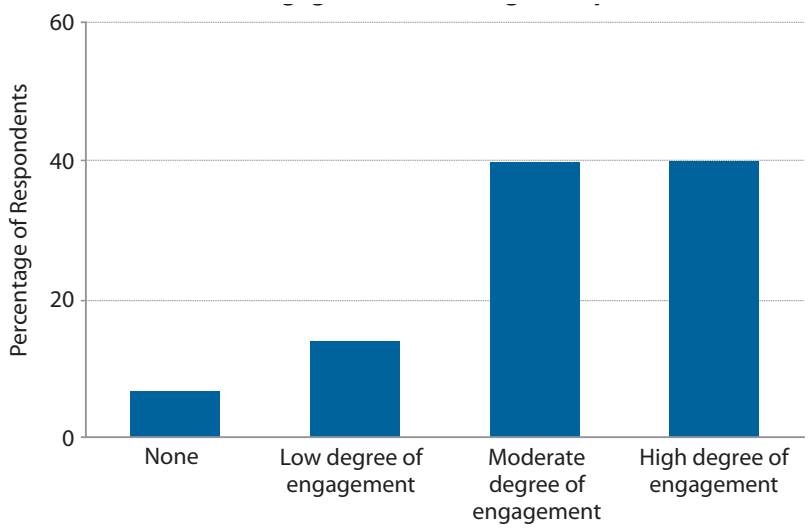
Even 89% of research organizations reported that they engaged with other research organizations to a 'moderate' or 'high' degree as a consequence of Tekes support. On the other hand, 80% of organizations reported that they engaged with large companies, 77% of organizations reported that they engaged with SMEs, respectively, to a 'moderate' or 'high' degree as a consequence of Tekes support (Figures 20–22). These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of research organizations, and further bolsters the need for continued engagement with companies and other research organizations.

Figure 20. Engagement with research organizations.



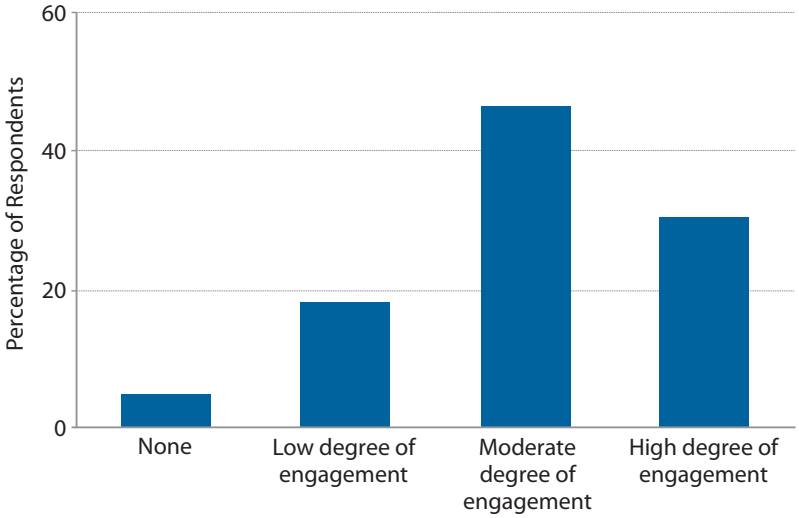
Since your first engagement with Tekes, to what degree has your organization engaged with research organizations as a consequence of Tekes support?
n=569

Figure 21. Engagement with large companies.



Since your first engagement with Tekes, to what degree has your organization engaged with large companies as a consequence of Tekes support?
n=566

Figure 22. Engagement with SMEs.



Since your first engagement with Tekes, to what degree has your organization engaged with SMEs as a consequence of Tekes support? n=579

Main findings of the electronic survey (Section 3.1)

- Overall, since their engagement with Tekes, the majority of respondents indicated that company's or research organization's ability either improved or stayed the same for all capabilities analyzed.
- Product design, prototyping, or testing capability was identified as the capability for which the greatest change of companies was reported. The New research models capability was identified by research organizations as the capability for which they experienced the greatest change.
- While Tekes support is playing an important role in improving companies' or research organizations's overall capabilities, it is not significantly impacting each of the individual capabilities.
- There is a need to 1) feed the results of the study into Tekes' decision-making on capabilities that would be the focus of Tekes' interventions, 2) test the impact of Tekes' interventions, in particular, using TEN's methodology and regression analyses to identify which capabilities are having the most impact on companies' or researchers' performance.
- On the basis of the above Table 23 (in the overall Conclusions of this report Chapter 5) suggests a categorization of capabilities which could be relevant for Tekes.

3.2 Results of the Tekes follow-up responses

The aim of this section is to analyze the "Tekes three years after" survey data in order to answer to following questions provided in the original assignment:

- **Question 5:** How large firms and research organizations and universities have answered to questions concerning the organization level impacts and Tekes intervention?
- **Question 6:** How the large firms and research organizations and universities have answered to question about innovation capabilities and broader impacts to the networks and the whole sector? (spillovers in other actors as well as society and economy)

Tekes gathers data about the impacts of the projects funded three years after the projects have ended. The data is gathered by an electronic survey to the funded projects. In the case of this study, the focus is on surveys to 1) large companies' projects and 2) research organizations' projects.

The analysis is limited to the projects which have ended between 2009–2010 (i.e. answered to "Tekes three years after" survey in 2012 or 2013). The survey template was updated by Tekes in 2012 and therefore the older projects have been excluded from this analysis.

There are in total 15 and 17 questions in the survey questionnaires for the research organizations and large companies respectively. This analysis focuses on the following questions, identified as the most relevant for the purposes of the questions provided in the assignment. For each of the questions, a set of subquestions / impact areas had been identified (see figures).

The scale for each questions was from 1 to 5 where 1 equals no significance ("ei merkitystä") and 5 invaluably significant ("korvaamattoman tärkeä merkitys"). However, it should be noted that for some projects, a scale from 0 to 100 was used. In order to make the data coherent, the 0-100 scale was transferred to 1–5 scale as follows:

Table 14. Selected questions for the analysis.

	Large Companies	Research organizations
Organizational level impacts	Q8 in the questionnaire: "How significant the project was for developing business competence and innovation capabilities?"[17]	Q9: "How significant impacts the project has had on the research activities within your organization?"[18]
	Q9: "How significantly the project impacted the operations and the public image of the company?"[19]	Q10: "How significantly the project impacted the operations and the public image of the organization?"[20]
Broader impacts	Q10: "How significant broader impacts do you think the project has in the industry, business chains or innovation networks of your company"?[21]	Q11: "How significant broader impacts do you think the project has in the industry, business chains or innovation networks of your organization?"[22]
	Q11: "How significant broader social impacts do you think the project has on the following areas of impact?"[23]	Q12: "How significant broader societal impacts do you think the project has on the following areas of impact?"[24]

Table 15. Scales in the analysis.

Scale 0–100	Scale 1–5	Finnish legend	English legend
0–29	1	Ei merkitystä	No significance
30–49	2	Vain vähän merkitystä	Weakly significant
50–69	3	Jonkin verran merkitystä	Moderately significant
70–89	4	Paljon merkitystä	Very significant
90–100	5	Korvaamattoman tärkeä merkitys	Invaluably significant

17 "Kuinka suuri merkitys projektilla oli liiketoiminta-osaamisen ja innovaatiokyvykkyyksien kehittymiseen?"

18 "Kuinka merkittäviä vaikutuksia projektista on ollut tutkimustoiminnalle tutkimuslaitoksessanne?"

19 "Kuinka merkittävästi projekti vaikutti yrityksen toimintoihin ja julkikuvaan seuraavilla osa-alueilla?"

20 "Kuinka merkittävästi projekti vaikutti tutkimuslaitoksenne toimintoihin ja julkikuvaan seuraavilla osa-alueilla?"

21 "Miten merkittäviä laajempia vaikutuksia arvioitte projektista olevan toimialalla, liiketoimintaketjussa tai innovaatioverkostossa, jossa yrityksenne toimii? (ulkoisvaikutukset elinkeinoelämässä)"

22 "Miten merkittäviä laajempia vaikutuksia arvioitte projektista olevan toimialalla, liiketoimintaketjussa tai innovaatioverkostossa, jossa yrityksenne toimii? (ulkoisvaikutukset elinkeinoelämässä)"

23 Miten merkittäviä laaja-alaisia yhteiskunnallisia vaikutuksia arvioitte projektilla olevan seuraaviin vaikutusalueisiin? (Ulkoisvaikutukset yhteiskunnassa)

24 Miten merkittäviä laaja-alaisia yhteiskunnallisia vaikutuksia arvioitte projektilla olevan seuraaviin vaikutusalueisiin? (Ulkoisvaikutukset yhteiskunnassa)

3.2.1 Organizational level impacts

How significant the project was for developing business competence and innovation capabilities? (large companies)

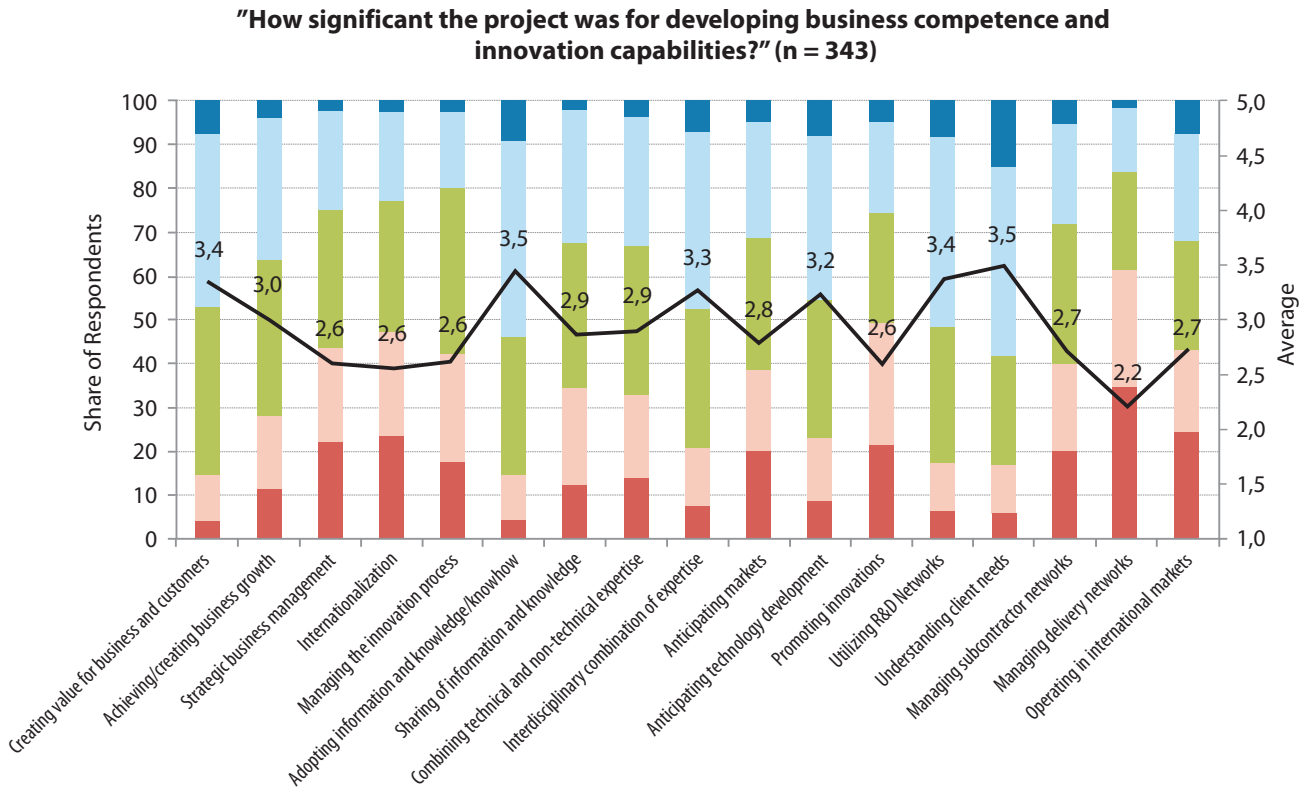
According to the responses of the large companies (n=343), the areas of business competence and innovation capabilities in which the significance of the projects was considered the greatest were:

- "Understanding client needs" (3.5),
- "Adopting information and knowledge knowhow" (3.5),
- "Creating value for business and customers" (3.4) and
- "Utilizing R&D networks" (3.4)

The areas in which the projects were considered to have the weakest significance were:

- "Managing delivery networks" (2.2)
- "Promoting innovations" (2.6)
- "Strategic business management" (2.6)
- "Internationalization" (2.6) and
- "Managing the innovation process" (2.6)

Figure 23. "How significant the project was for developing business competence and innovation capabilities"? Tekes three years after questionnaire for large companies, projects ended 2009–2010. N=343.



How significant impacts the project has had on the research activities within your organizations? (research organizations)

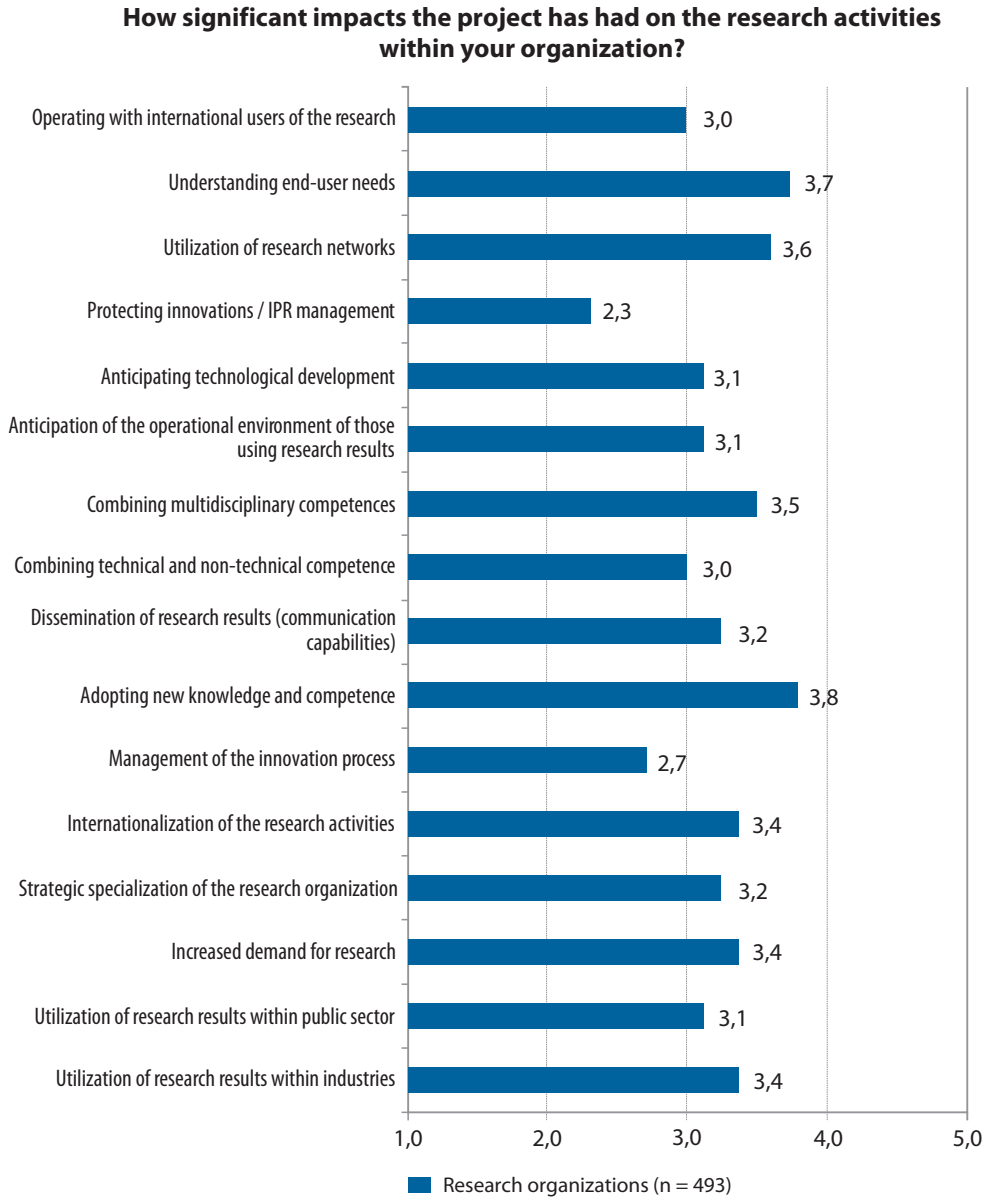
The research organizations were asked how significant impacts the project has had on the research activities within the organizations. According to the results, the significance of the projects is greatest (3.5 or more) in the following areas:

- "Adopting new knowledge and competence" (3.8)
- "Understanding end-user needs" (3.7)
- "Utilization of research networks" (3.6)
- "Combining multidisciplinary competence" (3.5)

The significance was considered the weakest (under 3.0) in the following areas:

- "Protecting innovations / managing IPR rights" (2.3) and
- "Managing innovation process" (2.7)

Figure 24. How significant impacts the project has had on the research activities within your organizations? Tekes three years after questionnaire for research organizations, projects ended 2009–2010. N=493.



How significantly the project impacted the operations and the public image of the company?

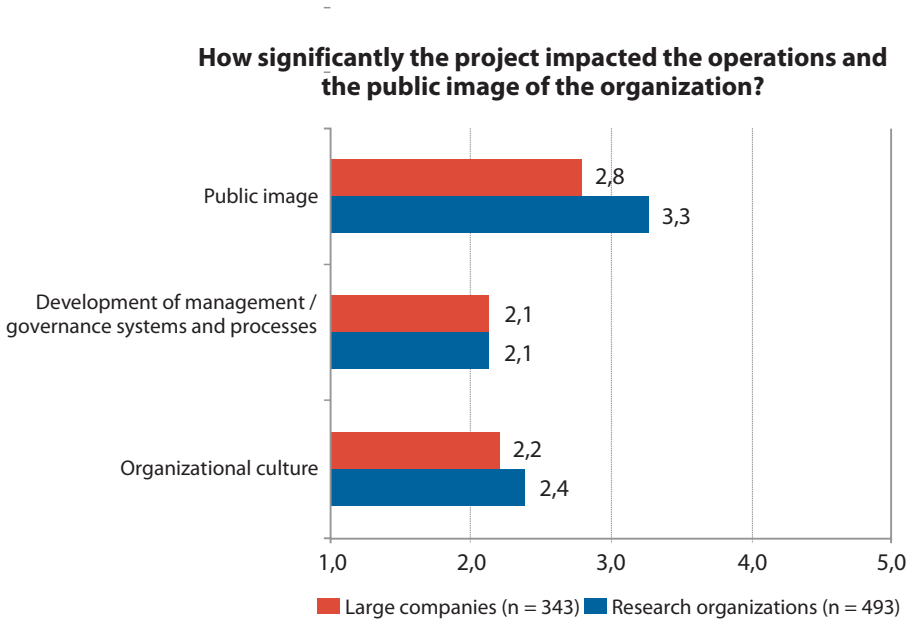
Large companies

The companies were also asked how significantly the project has impacted the operations and the public image of the company. The analysis shows that the significance of the projects in developing management/governance systems/process (2.1) and impacts on organizational culture (2.2) were considered only weakly significant on average. As for the public image of the company the significance of the project was considered as moderate (2.8).

Research organizations

Also the research organizations were asked how significantly the project has impacted the operations and the public image of the organization. The analysis shows that the significance of the projects in developing management/governance systems/process (2.1) and impacts on organizational culture (2.4) were considered only weakly significant on average. As for the image of the organization the significance of the project was considered as moderate (3.3). The results are slightly better compared to the responses of large companies.

Figure 25. How significantly the project impacted the operations and the public image of the company? Tekes three years after questionnaire, projects ended 2009–2010. N=343.



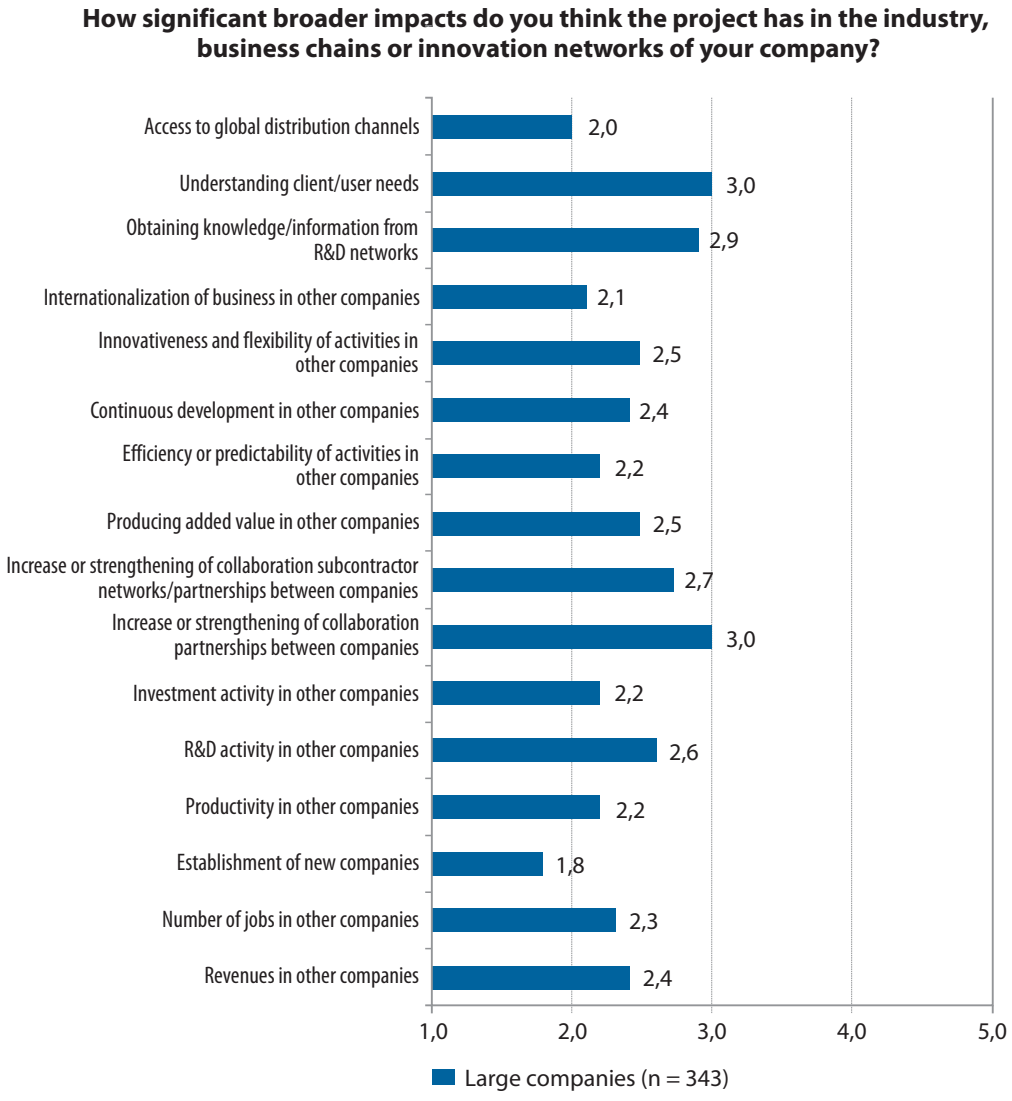
3.2.2 Broader impacts

In addition to organizational level questions, the companies and research organizations were also asked the broader impacts of the projects a) on the industry and b) on the society as whole.

How significant broader impacts do you think the project has in the industry, business chains or innovation networks of your company/organization?

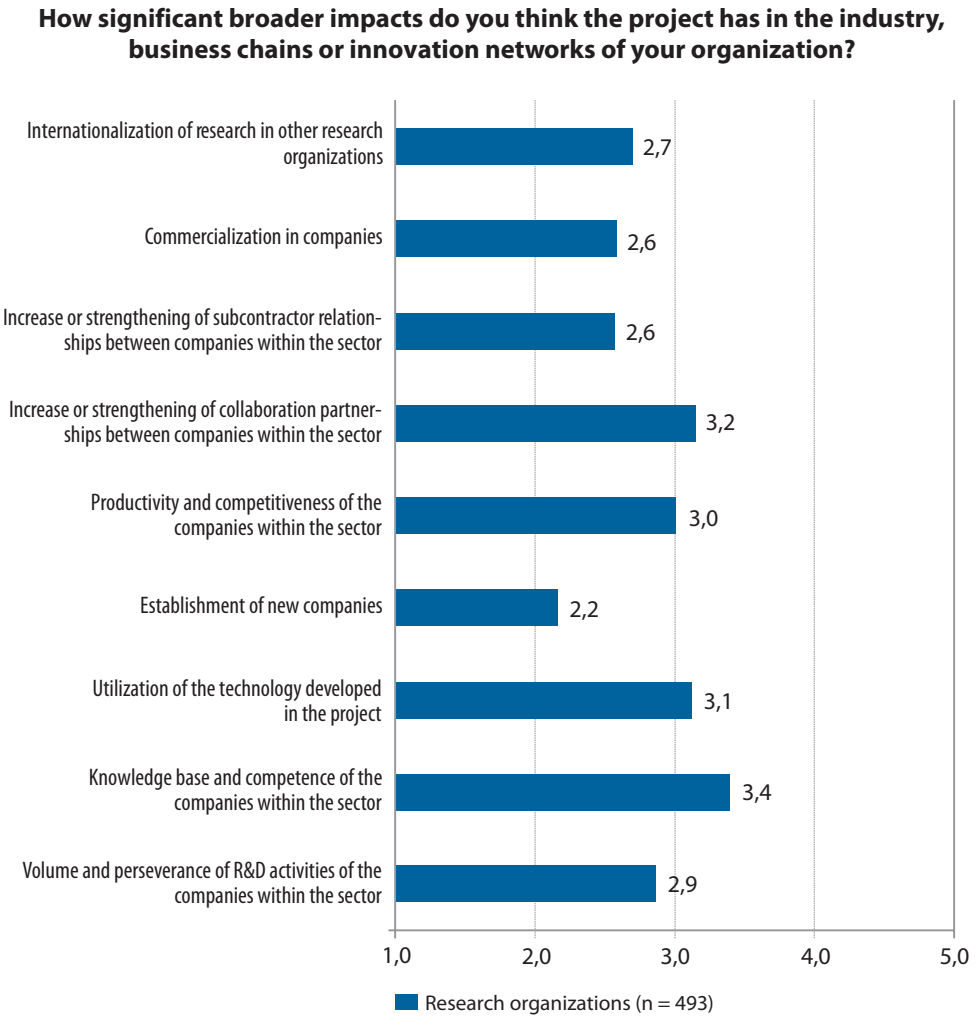
The analysis shows the companies do not attribute significant industry level impacts to the projects. Only two areas scored 3.0 on average. Most areas scored under 2.5 on average.

Figure 26. How significant broader impacts do you think the project has in the industry, business chains or innovation networks of your company/organization? Tekes three years after questionnaire for large companies, projects ended 2009–2010. N=343.



The research organizations assess the impacts of the projects greater, with only one of nine areas receiving scores under 2.5 and four areas receiving scores 3.0 or more.

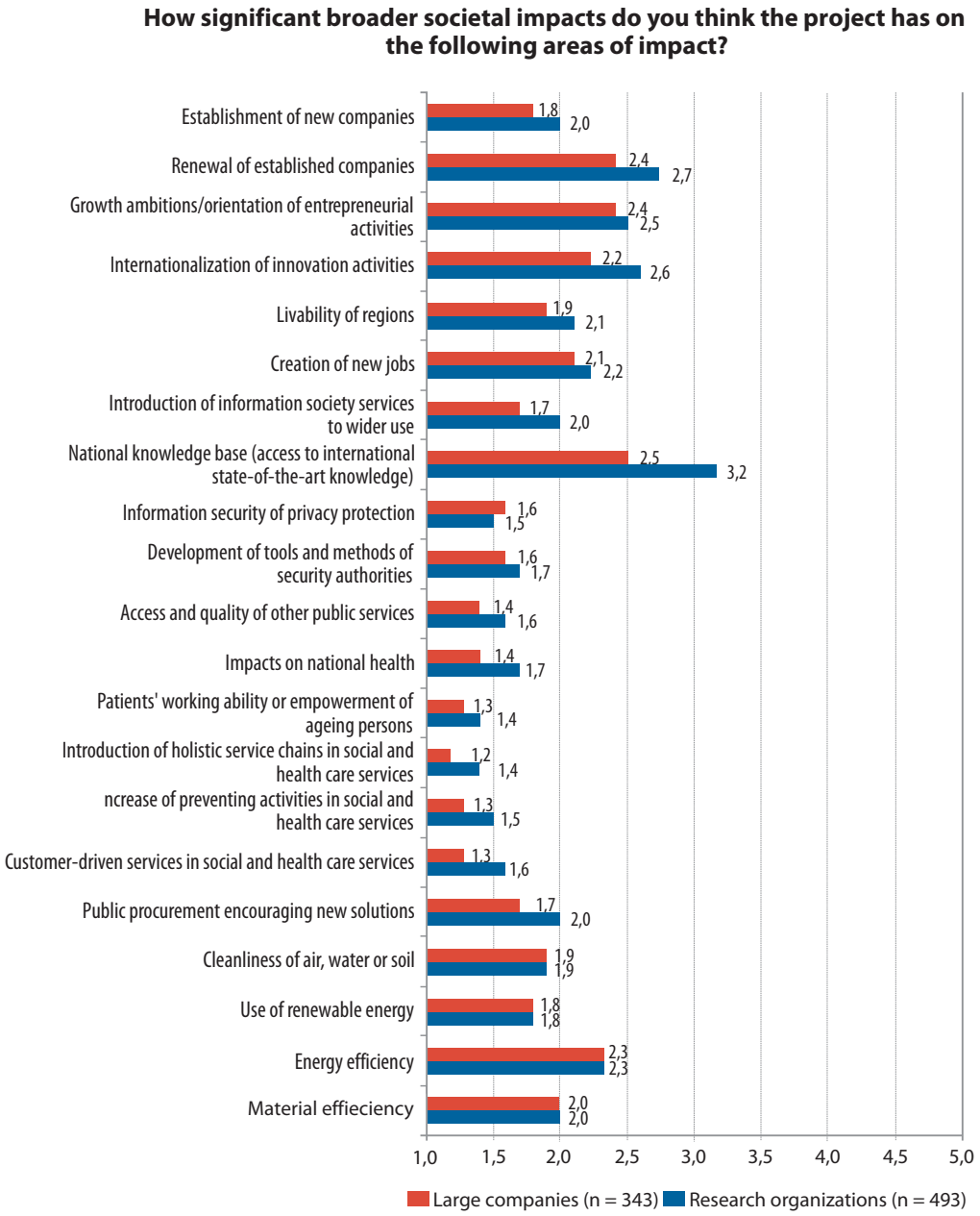
Figure 27. How significant broader impacts do you think the project has in the industry, business chains or innovation networks of your company/organization? Tekes three years after questionnaire for research organizations, projects ended 2009–2010. N=493.



How significant broader social impacts do you think the project has on the following areas of impact?

As for the broader social impacts, the significance of the projects was considered to be very limited by both large companies as well as research organizations. Research organizations were slightly more positive on average. According to research organizations the projects had moderately significant impact to "national knowledge base" (3.2 or higher)

Figure 28. How significant broader social impacts do you think the project has on the following areas of impact? Tekes three years after questionnaire, projects ended 2009–2010.



Main findings of the Tekes follow-up responses (Section 3.2)

- Overall, the Tekes follow-up responses conducted three years after project completion do not provide much precise information regarding capability development, but do provide a general picture on the project success and its broader impacts.
- Although the responses of research organizations and large companies were not entirely comparable, on average the research organizations assessed the organizational level impacts and/or significance of the projects greater than the large companies.
- In most areas, large companies assessed the significance of projects as only moderate, which raises questions about the achieved impacts and/or the relevance of the areas in question.
- In general, the projects have had the greatest significance in areas related to knowledge sharing, interdisciplinarity and combining different competences, as well as in helping to understand the needs of final beneficiaries of the products or services.

3.3 Case studies

Each case study is presented separately in the following tables. For the selection of cases see 2.3. The conclusions of the case studies are presented in the end of the section.

Table 16. Case study: Kemira Oyj.

CASE

Kemira is a global company focusing on pulp and paper, oil and gas, mining and water treatment. It provides expertise and chemicals that improve their customers' water, energy and raw material efficiency. In 2013, Kemira had annual revenue of EUR 2,229 million and 4,453 employees. Headquartered in Helsinki, Kemira has operations in approximately 40 countries and sales to more than 120 countries. The company aims at achieving 10 % of revenue from innovation sales or sales from new products in 2016. Kemira shares are listed on the NASDAQ OMX Helsinki Stock Exchange.

In 2009, Kemira made a decision to start a four years R&D program in collaboration with VTT (The Technical Research Center of Finland). The program called SWEET (Center of Water Efficiency Excellence), was launched in 2010 and it ended in 2013. The total costs of the program for four years were 120 million euros. The program comprised around 60 subprojects, and employed annually altogether 200 people, many of them at Kemira's R&D centers located in Espoo, Atlanta, Shanghai and Sao Paulo.

Kemira's strategic partners in SWEET were, apart from VTT, the Finnish companies Outotec and Metso, Singapore's National Water as well as PUB – Public Utility Board and Nanyang Technological University. Many Finnish universities (e.g. Aalto University, University of Helsinki) and small and medium sized companies have been involved in several SWEET projects.

One of the main enablers for the recognition of the importance of SWEET inside the company was commitment of Tekes to the financing of the program. Tekes support has been considered by representatives of Kemira very important for the realisation of the SWEET program. In particular, it made for Kemira possible broad-based networking with research institutes as well as small and medium sized enterprises in Finland.

The ultimate aim of the program, which by Kemira's and more generally also by Finnish standards was unusually ambitious, was to accumulate the excellence of water research in Finland and elsewhere in a new way and to produce new kinds of solutions for better management of water usage. The areas of focus of the SWEET program were the reutilization of water, a better utilization of biomasses, for example, in the production of energy and biofuels as well as the hydrochemistry of sustainable development, which develops bio-based, biodegradable solutions based on recycling.

The projects of SWEET resulted in new know-how for Kemira and its partners and improved their understanding of the areas worth investing in the future. The program gave rise to numerous product innovations, such as tagged antiscalants associated with oil drilling, by means of which Kemira differentiates itself from its competitors. The most significant success of the program has been that 70 per cent of sales of Kemira's new products in the commercialization phase have come from the results of SWEET. In 2013 these projects generated turnover to Kemira as much as 120-140 million euros. Many are still at the product development stage.

Water technology as a whole drew in Finland more attention during the course of the program, and today it is an important part of Finnish Cleantech related operations. Kemira's cooperation continues with the partners of SWEET.

The case SWEET demonstrates that the importance of the role of Tekes for companies is not limited to sharing the financial risk of R&D. Also in big companies such as Kemira Tekes support for R&D project or program creates a positive atmosphere and commitment not only among R&D personnel but among top management of the company, too. This is of great help in realizing ambitious R&D efforts. The criteria and practices which Tekes is using when providing financial support to companies has encouraged in a positive way Kemira to intensify cooperation and interaction with key customers, research institutes, universities, and not least with small and medium sized companies. Some of the SWEET projects have been linked with SHOKs Fibic and Cleen. The SWEET program has increased Kemira's and other partners' capabilities at product design, prototyping and testing.

Kemira				
Impact of Tekes on capabilities	**High**	**Medium**	**Low**	**No**
Customer engagement capabilities		X		
Domestic or international market capabilities				X
Promotion and communication capabilities				X
Knowledge management capabilities		X		
Supply chain management capabilities				X
Operational efficiency capabilities		X		
Product design, prototyping, or testing capabilities	X			
Intellectual property protection capabilities		X		
New business model capabilities		X		
Scanning or networking capabilities	X			
Regulatory conformance capabilities				X
RDI collaboration capabilities	X			
Capability to acquire financial resources				X
Competency management and development capabilities		X		

Interviewee: Kari Saari, Vice President, R&D and Technology

Table 17. Case study: **Teleste Oyj.**

CASE

Teleste, founded in 1954, is an international technology company that develops and offers video and broadband products, services and solutions for cable operators, telecom companies and the public sector, in e.g. traffic and transportation, military and border control, as well as police, fire and rescue service. The core business of the company is video - image and data processing, transfer and management. Manufacturing of the company is mainly in Finland with offices in 20 countries. The number of personnel in 2013 was 1300, net sales 193 million euros, and R&D expenditure 10.00 million euros.

Teleste has been working with Tekes from late 1970s. Support from Tekes enabled Teleste to build capacities in emerging technologies such as satellite systems and fiber optic cable technologies. These have later formed a major part of the technology base needed for continuous development of Teleste's products and services. In recent years Tekes financial support has been used for further development of core technologies, increasing competitiveness of existing products and services, but in a minor scale also for development of logistics, production and work organizations.

The most recent projects financed by Tekes have been VISI, ENGINES, PIKO and H2B2VS**.** Teleste has been involved in three projects of Eureka programme "ICT Cluster for a Smart Connected world (Celtic). The company is one of the owners of Digile and participant in its R&D activities. In R&D Teleste is in many ways networked with other companies, universities, polytechnics and research institutes.

Technological development in cable networks and related broadband and video solutions is undergoing a rapid and complex change. Functionality of networks combining conventional coaxial cable and optical fiber can be improved by adding intelligent features in them. Meeting the new challenges requires intensive interaction with customers, focused R&D efforts and close cooperation with experts of various technological fields as well as service providers.

The vast majority of Teleste's R&D is carried out within the company with its own funds. The importance of financial support from Tekes is bigger than the share of Tekes financing of total R&D expenditure of Teleste. In particular, Tekes support has encouraged the company to design and implement bigger R&D programmes including participants from small companies, universities (Aalto University, Technical University of Tampere, University of Oulu, Åbo Akademi University) and polytechnics. This cooperation has turned out useful to all partners, and it has resulted in a couple of start-up firms, too e.g**.** Milaris Ltd and Debuginfo.

Teleste				
Impact of Tekes on capabilities	**High**	**Medium**	**Low**	**No**
Customer engagement capabilities				X
Domestic or international market capabilities			X	
Promotion and communication capabilities				X
Knowledge management capabilities	X			
Supply chain management capabilities		X		
Operational efficiency capabilities	X			
Product design, prototyping, or testing capabilities		X		
Intellectual property protection capabilities		X		
New business model capabilities	X			
Scanning or networking capabilities		X		
Regulatory conformance capabilities				X
RDI collaboration capabilities	X			
Capability to acquire financial resources				X
Competency management and development capabilities		X		

In terms of capabilities, the role of Tekes for Teleste has been most significant in RDI collaboration and networking capabilities (networking with companies and universities), new business model capabilities (new knowledge for technology such as cloud services) and operational efficiency capabilities (management R&D project portfolios). Instead capabilities related to customer engagement, domestic and international market, promotion and communication, regulatory conformance and acquirement of financial resources.

Tekes financial support and expertise available from Tekes has entailed added value to development of Teleste's strategic technologies and management of innovation processes. The expectations of the company from SHOK, mainly Digile have not come fully true yet. In the past Teleste had close cooperation with VTT. Its competencies in satellite systems and optics which are valid still today, were very much built in collaborative ventures with VTT's experts. In recent years cooperation with VTT has been lower than previously.

Interviewee: Ilkka Ritakallio, Director, New Applications Research and Development

Table 18. Case study Ponsse Oyj.

CASE

Ponsse Plc is a family based company established in 1970. The Company has its registered office in Vieremä, Finland. Ponsse is one of the world's leading manufacturers of forest machines for the cut-to-length method. Ponsse's product range covers all size categories of forest machines, from first thinning and harvesting of forest energy to heavy-duty regeneration felling. Ponsse also designs and manufactures all of the control and measuring systems needed for the wood procurement chain. In the year 2013 Ponsse Group recorded net sales amounting to EUR 312.8 million and an operating result of EUR 22.5 million for the period. The expenditure for R&D was EUR 9,7 million. The Group had an average staff of 1027.

Ponsse has participated from the year 1991 in several projects (about 20) funded by Tekes. Last projects are Simulator-assisted testing (2008-2009), Ponsse Network (2008-2010), Activity control of machine and driver (2010-2011), New concept for harvesting (2011-2013) and Manu-program of Fimecc (Future digital manufacturing technologies and systems, 2012-2017).

The aim of Tekes collaboration has been to reach resources for long-standing development and create conditions for new products and services and continuous improvement of competitiveness. Tekes funding has been used especially for new product development and enhancing the infrastructure of testing, for example the using of simulation in product development. The other important target has been the establishment of "ideal factory", that is, the creation of world-class production system and supplier network. In Ponsse Network project there was created The Ponsse Production System PPS tailored for Ponsse's production needs. In part of the development of supplier network an entrepreneur village has emerged in Vieremä. This new production concept is under further development in Manu-program of Fimecc.

Tekes funding is no more used for direct product development and, for example, the new most advanced harvester Scorpion has developed by Ponsse's own funding. Besides, the new concept for harvesting has been tested in simulator, but a prototype is not implemented.

Ponsse is not identifying itself as a service company; instead, it is concentrating to produce high-quality forest machines and information technology related to harvesting. Still, the service element is in a central position in the business concept of Ponsse. For customers the availability of service locally and in field is a crucial factor of purchasing decision. Also training is necessary to help customer to use harvesters in a proper way. For that Ponsse has developed in Tekes projects Ecodrive application, which informs the driver whether he is using the machine in an effective way. Together, service, training and spare parts generate 20 % of the income in 2013.

Ponsse's experiences of projects funded by Tekes have been very positive and a majority of applications has been accepted. Instead, the attitude towards SHOKs (Strategic Centres for Science, Technology and Innovation) is reserved, because the results are public and this might contain a risk in the condition of strong competition.

In projects Ponsse has collaborated with universities and research centres, especially with Lappeenranta University of Technology and Tampere University of Technology, but also with University of Oulu, Aalto University, and VTT Technical Research Centre of Finland. The services of Creanex Oy has also used in development. In these projects Ponsse has adopted new research knowledge and learned to collaborate with universities. The viewpoint of researchers has been more general than Ponsse's, because Ponsse is very focused to practical solutions to problems it faces in developing future generation products. Ponsse's subcontractors and suppliers have actively participating to the creation and development of supplier network, especially Ratesteel, HT Lasertekniikka, Hytar and SKS Connecto from entrepreneur village of Vieremä. In this process there has been co-created new capabilities, which improve the quality of products, delivery reliability and collaboration of suppliers.

In general, the impact of Tekes projects has been considerable in supply chain management capabilities (e.g. Ponsse Network project and Manu-program), operational efficiency capabilities (e.g. Ponsse Network and Simulator-assisted testing), product design, prototyping, and testing capabilities (e.g. Simulator-assisted testing and Activity control of machine and driver) and RDI collaboration capabilities (all projects). Summary is in the table.

Ponsse Oyj				
Impact of Tekes on capabilities	**High**	**Medium**	**Low**	**No**
Customer engagement capabilities				X
Domestic or international market capabilities				X
Promotion and communication capabilities				X
Knowledge management capabilities		X		
Supply chain management capabilities	X			
Operational efficiency capabilities	X			
Product design, prototyping, or testing capabilities	X			
Intellectual property protection capabilities			X	
New business model capabilities			X	
Scanning or networking capabilities		X		
Regulatory conformance capabilities				X
RDI collaboration capabilities	X			
Capability to acquire financial resources			X	
Competency management and development capabilities		X		
Summary	**4**	**3**	**3**	**4**

Interviewees: Juho Nummela, President and CEO, Juha Inberg, Director, Technology and R&D

Table 19. Case study: **Bayer Oyj**.

CASE

Bayer Schering Pharma Oy (**Bayer Oy** at present) is the center of competence for development of polymer based delivery systems in the Bayer Group. Bayer Schering Pharma Oy is specialized in long-acting polymer-based pharmaceuticals and tablet production. The production site in Turku produces pharmaceuticals to global markets. In 2013, Bayer employed 113,200 people and had sales of €40.2 billion. Capital expenditures amounted to €2.2 billion, R&D expenses to €3.2 billion.

The Tekes projects have focused on technology and R&D. The main focus has been on the development of new materials and testing. In addition to the development project of laser-ultrasonic measurement technique, Bayer Schering Pharma Oy has had a number of Tekes projects earlier in 2000s e.g. a total of 11 projects in 2000-2005. Furthermore, representatives of the Bayer Schering Pharma Oy have also had Steering Committee memberships in other Tekes projects.

Tekes has had a major impact on improving capabilities to collaborate with research institutes e.g. VTT, universities e.g. University of Helsinki, Åbo Akademi and Aalto University, and SMEs in Finland. For example, VTT has been a very important partner. This study project was performed in co-operation with University of Helsinki, Electronics Laboratory. The collaboration partners have varied between the projects. The SMEs have been included in Tekes projects in case of special expertise.

Based on long experience, RDI collaboration is the key issue in Tekes projects. In some cases, the collaboration has also continued after the R&D phase e.g. in product supply. The reason for the collaboration in Tekes projects has been that specific field of expertise has been needed in product development. In case of Tekes projects, the partners can e.g. provide some equipments for product development. The partners provide something what Bayer does not have or does not have enough or which cannot be bought from the shell. Furthermore, it was stressed that it is important to develop together. Despite the added value of the networking, sometimes the Tekes projects have been found too big. The challenges are the high number of sub-projects and the number of different partners.

Tekes has had an impact on improving the capability to design new products and processes. New technology can be applied in new products and processes. Also, the use of patents has been improved due to the development of new products in Tekes projects.

Furthermore, the capability to manage supply chain has been improved. An online system has been developed to monitor supply chain and also to improve the quality of the products. The quality is critical in pharmaceutical industry. The operational efficiency was not a topic as such, but Tekes project has indirectly improved process related to efficiency.

On the other hand, Tekes support has not led to improvements of several capabilities such as new business model, market, customer engagement, and knowledge management capabilities and capabilities to raise capital. Bayer is a large international pharma company and the company has in-house (in other departments) e.g. regulatory conformance capabilities as well as capabilities to develop, and adopt new business models. A large company does not expect Tekes support for several capabilities. For example, a big pharma company may have better expertise in e.g. regulations compared to Tekes. So far, Tekes support has not contributed to acquiring human resources. Bayer is open to hiring new employees, although there has been no mobility in the network.

Tekes project: Ultrasonics & Laseracoustics for noncontact quality control of polymer based applications (2009-2012).
Interviewee: Vice-President, Dr. Joachim Moede

Table 20. Case study: **Strategic opening Human spare parts.**

CASE

Tekes funds strategic research openings, which have a high degree of scientific vision, aiming to make discoveries that will lay the basis for new areas of business. **The Human Spare Parts**, which has been funded by Tekes since 2011, is the first one of the Tekes' strategic openings.

The Human Spare Parts is comprised by the research groups of both the University of Tampere (BioMediTech) and Tampere University of Technology (Department of Department of Electronics and Communications Engineering and Department of Automation Science and Engineering). The aim of the strategic opening is to find better and more cost-effective ways to build spare parts for people from their own cells.

According to the interviews, the strategic opening of the Human Spare Parts was started after intensive dialogue between Tekes and the University of Tampere (UTA) and the Tampere University of Technology (TUT). The funding from the Council of Tampere Region (i.e. Pirkanmaan liitto) was a precondition for the Tekes funding (10 million euros for the years 2011-2014). Correspondingly, the Tekes funding helped to receive the funding from the Council of Tampere Region. Thus, Tekes has contributed indirectly to the ability to access experimental facilities or resources. The structural development and the infrastructure of the new joint institute i.e. BioMediTech (Institute of Biosciences and Medical Technology) of UTA and TUT was funded by the Council of Tampere Region (originally EAKR funding). The BioMediTech is the host institute for the Human Spare Parts. The researchers have the possibility to work in the facilities of both universities. The Human Spare Parts has also been used as a good example in an ongoing investigation concerning unification of UTA, TUT and the Tampere University of Applied Sciences.

Both Tekes funding and non-financial support have enabled the change of the operation environment in which the strategic aims of the Human Spare Parts have been defined in co-operation between the research groups of two universities. The strategic objectives, which required new capabilities, were also discussed in co-operation with Tekes. According to the interviewees, the capability to develop linkages between strategic focus and research plans has been clearly improved. All eight research groups of the Human Spare Parts have a joint strategic focus. It was said that the experiences of the Human Spare Parts affect positively on designing other research projects. It seems that the capability to design strategic research is more and more important. For example, a new funding instrument "Strategisen tutkimuksen neuvosto" of the Academy of Finland will emphasize the strategic directions of research.

Tekes has had a major impact on the ability to upgrade human resources. The Human Spare Parts covers a total of 120 persons, of which 40 are working full-time on this strategic opening. Majority of the Tekes funding is used for human resources. The Human Spare Parts has a full-time project manager. This operation mode has contributed to developing non-scientific capabilities. According to the interviewees, the long-term funding for human resources as well as the infrastructure have been the key factors for success. It should be noted that the Tekes support and the existing infrastructure have had a catalytic effect on receiving other funding e.g. from universities.

The Human Spare Parts has succeeded in creating truly multidisciplinary research groups and interdisciplinary projects. The Human Spare Parts combines expertise in biomaterials, sensor technology, biomedical engineering and stem cells to develop technologies and solutions leading to new therapies and drugs. In practice, researchers from both universities (UTA and TUT) are represented in each research group. Furthermore, some researchers participate in the work of several research groups of the Human Spare Parts. According to the interviewees, a remarkable advantage is that the researchers have the possibility to discuss face-to-face. It is crucial that both universities are located close to each other in Tampere. The Human Spare Parts holds internal meetings regularly. The researchers appreciated the opportunity to learn from each other in a multidisciplinary community. According to the interviewees, despite the high number of internal meetings, working in a big community is preferred in comparison to ordinary small-scale research projects. The expertise and research findings are divided openly in the Human Spare Parts community already before the results are published.

Attractiveness of the research environment has been improved during Tekes support on Human Spare Parts. The infrastructure and the top quality research are the basis for the ability to attract talented researchers both from Finland and from abroad. However, the researchers were concerned about how to keep the experimental facilities e.g. equipments up-to-date in the future. According to the interviews, the researchers stay motivated to continue in this dynamic research environment. In the beginning, it was difficult to receive applicants from abroad. Currently, approximately half of the post doctoral researchers are from abroad. Even most of the applicants for the tenure track positions come from abroad.

The capability to identify potentially valuable intellectual property (IP) has been clearly improved in this strategic opening. The main point is that the expert on IPR issues is working in the same community. The BioMediTech has been able to recruit an expert on IPR issues by the funding from the Council of Tampere Region. Based on the interviews, the number of patent applications 10 is higher than expected. The interviewees said that the IPR process helps to focus the research too. As a good practice, the protection of intellectual property is discussed regularly at the internal meetings of the Human Spare Parts. Moreover, all IP rights belong to the universities due to the absence of the companies in the Human Spare Parts. Tekes has contributed indirectly to the improvement of IPR issues, because Tekes funding can also be used for covering external services such as the processing of the concrete patent applications.

So far, learning from the companies has been limited, because companies do not participate in the Human Spare Parts. According to Tekes, no business participation is required in the strategic openings. The Human Spare Parts has a large co-operation network, which includes both SMEs and large companies locally, nationally and internationally. The network of companies is needed for the development of prototypes. The Human Spare Parts has succeeded in the development of prototypes. In the near future, one of the prototypes will be commercialized by a company. The researchers are pleased with the new common practice to discuss the development of prototypes. Only some research groups of the Human Spare Parts have had earlier experience in developing prototypes, whereas others have not. Furthermore, all project managers of the Human Spare Parts have gone a course on utilization of the research results.

Tekes support has had a major impact on the increased capability to promote research results in different ways. The Human Spare Parts has a protocol concerning communications. For example, some research results have not yet been published because of the ongoing patent applications. In addition to ordinary participation in scientific conferences, the principal investigators have participated altogether in international events. Based on the interviews, it is easier to gain visibility as a big research group. For example, the strategic opening was presented at the seminar on human spare parts, in which the Nobel Prize winner and the Millennium Prize winner, a co-operation partner, hold the keynote lecture. Furthermore, it is an advantage that the Human Spare Parts is an interesting topic for public audience. Also, the Finnish name "Ihmisen varaosat" of the strategic opening is a memorable name for popularization of research.

Summary. Since receiving Tekes support, to what degrees have each of the following mechanisms impacted your research or your organization's overall capabilities?

Strategic opening Human spare parts	Very significant impact	Significant	Some impact	No impact
Upgrading of human resources	X			
New organizational processes, equipment, or infrastructure		X NB. EU funding on the infra		
Pursuit of a new strategic objectives that required new capabilities	X			
Tekes financial support	X			
Tekes non-financial support	X			
Learning from companies			X	
Learning from other researchers or research organizations			X	

Project: Strategic opening Human spare parts, University of Tampere and Tampere University of Technology
Tekes funding: 10 million euros (2011–2014)
Interviewees: Juho Väisänen and Susanna Narkilahti (University of Tampere), Jari Hyttinen and Minna Kellomäki (Tampere University of Technology), Hannu Hanhijärvi (BioMediTech)

Table 21. Case Study: **Strategic opening NEO-CARBON ENERGY.**

CASE

Tekes funds strategic research openings, which have a high degree of scientific vision, aiming to make discoveries that will lay the basis for new areas of business. So far, Tekes funds a total of eight strategic research openings. The proportion of Tekes funding on the **NEO-CARBON ENERGY** (5 million euros for the years 2014-2016) is 70%.

NEO-CARBON ENERGY aims to pole position in developing future energy system. The objective is at an energy system that is based on solar and wind energy. The cross-disciplinary strategic opening combines the expertise of three organizations (VTT Technical Research Centre of Finland, LUT Lappeenranta University of Technology and University of Turku / The Finland Futures Research Centre).

Tekes has had a major impact on the ability to create a new co-operating model for the research institutions. It is a strategic focusing project for VTT and the universities too. The strategic focus was defined in co-operation between Tekes, VTT and the universities. According to the interviewees, it was a very useful learning process. The interviewees emphasized that real co-operation has worked from the very beginning. The NEO-CARBON ENERGY matches very well with the core of LUT's strategy, because one of the university's three strategic priorities is green energy and technology. The strategic opening is also nationally relevant. The target is that Finland will lead the way in developing the the new functions of solar and wind energy, including energy storage, in the future.

The strength of the NEO-CARBON ENERGY is that it has a well-planned management of research. The full-time project manager is financed by Tekes. The project office is located at LUT in Lappeenranta. For example, the capabilities to follow-up the roadmap and to optimize research capacity have been improved. In practice, the strategic opening holds monthly meetings, in which e.g. economic situation, results since last time and open questions and problems are reviewed together without organizational silos.

Tekes funding has enabled the capability to form a large researcher hub. The interviewees stressed that now it is possible to reach a sufficient critical mass by Tekes funding. Majority of Tekes funding is used for human resources and capacity building. The multidisciplinary approach includes e.g. energy technology, electrical engineering and solar economy (LUT), chemistry and infrastructure (VTT), and futures research and foresight (University of Turku). The NEO-CARBON ENERGY aims to gain system-level understanding of the transition to a renewable energy system and its technical, economic and environmental factors. The NEO-CARBON ENERGY is a forerunner in the field in Finland because the systemic level has not been studied before. Due to its horizontal integration in the energy system research it is assumed to have global competiveness.

Simultaneously with the beginning of Tekes funding, a new professorship on solar energy was established at LUT. Donation from Fortum Ltd supports the professorship for five years. According to the interviewees, this recruitment has been crucial both for competence building and networking capabilities of the NEO-CARBON ENERGY. The professorship, which is unique in Nordic countries, will focus on solar economy energy scenarios and market mechanisms. According to the interviewees, the attractiveness has been definitely improved due to synergistic effect of Tekes funding, new recruitments and the LUT's strategic theme of green energy. However, some expertise is still lacking and the NEO-CARBON ENERGY is looking for further recruitments. The strategic opening aims to create both high quality competence base and demonstration areas so that Finland would belong to the top three countries in this field.

Based on the interviews, the capability to create international research networks has already been remarkably improved by the Tekes support. Especially the international researcher exchange has been active already since the beginning. Currently, the researchers of the NEO-CARBON ENERGY are visiting research institutes e.g. in Germany and the US. Correspondingly, researchers from e.g. Germany, Russia, UK and Brazil are visiting LUT. Furthermore, the NEO-CARBON ENERGY, together with international partners, has applied for further research funding from EU. On the other hand, it is too early stage to assess the strategic opening's capability to affect international research agendas.

The NEO-CARBON ENERGY has succeeded in producing results of the simulation studies during the first steps of the strategic opening. The primary focus of the project is not to build up new infrastructures. The investment money, which is needed for infrastructure and testing tools, is applied from other sources than Tekes e.g. the EU and TEM but also universities and VTTown funding is used. However, Tekes support affects indirectly the capability to develop infrastructure due to the synergistic effect of multi-party funding arrangements.

Based on the criteria used by Tekes, no company funding is required in the strategic openings. The NEO-CARBON ENERGY receives no industrial funding. The Tekes support has an indirect impact commercialization of the results. The companies are represented in the Advisory Board of the NEO-CARBON ENERGY. Currently, a total of 14 companies, 2 associations, one fund and one public authority are currently represented in the Advisory Board. The companies represent mainly large-scale industry. The Advisory Board is an open platform to new members too. According to the interviews, the role of the Advisory Board is significant in reviewing the outcomes of the projects, disseminating the results as well as catalyzing new product, service and framework development outside the project. So far, the strategic opening has received the first assignments from companies.

The interviewees said that the Tekes support does not affect the intellectual property protection capabilities, which depend sooner on the individual researcher as well as the university's administrative support. However, the Tekes support affects the intellectual property protection capacity in case the patents will be registered. The aim is to protect by patents as much as possible. For example, a multidisciplinary demonstration project with commercialization potential has been planned.

It is too early stage to assess the capability of the NEO-CARBON ENERGY to disseminate results, however the results have attracted media and resulted in several print news stories and 2 TV appearances. Based on the interviews, it is expected that Tekes support does not contribute significantly to communication capabilities. Instead, the communications units of VTT and LUT are supporting the promotion of results. The NEO-CARBON ENERGY has a working package for dissemination. In addition to scientific publications, the use of newsletters, workshops, media briefs, policy briefs, innovation competitions and social media e.g. blogs have been planned and partially activated already.

As a summary, both Tekes financial and non-financial support have had a very significant impact on the capabilities to credibility, competence and network building of the NEO-CARBON ENERGY. So far, the impact on the capability to learn from companies has been limited. However, it should be noted that the present case study describes the impact on capabilities at the very early stages of this strategic opening.

Interviewees:
Project Manager Pasi Vainikka, VTT
Professor Jarmo Partanen, LUT

Tekes Project: NEO-CARBON ENERGY – to pole position in developing future energy system

Partners: VTT Technical Research Centre of Finland, Lappeenranta University of Technology (LUT), University of Turku/The Finland Futures Research Centre (UTU/FFRC)

Tekes funding: € 4 990 700 (2014-2016)

Table 22. Case Study: **SHOK DIGILE Data 2 Intelligence.**

CASE

DIGILE is one of the six *Strategic Centers for Science, Technology and Innovation* (SHOK) appointed by the Finnish government, with a specific focus on ICT and digital business. SHOKs are large research concentrations formally organised as private companies, with shareholders ranging from large industry and public organisations to academia. There are over 40 shareholders in DIGILE.

Five of the SHOKs are guided by a *Strategic Research Agenda (SRA)*, which is then operationalised into separate and more specific research programmes and projects. DIGILE is an exception for this practice, where instead of a single SRA thematic SRAs are created for DIGILE research themes. The current SRA-portfolio of DIGILE consists of four industry-driven research themes, all related to the acceleration of digital services. The four SRAs are: *Internet of Things (IoT), Data to Intelligence (D2I), Digital Services (DS)* and *Need 4 Speed (N4S)*. SRAs are implemented by a number of instruments, most notably by Tekes-funded SHOK-programmes. Amongst those, the D2I and IoT are considered to be two sister programmes that are running in parallel to each other. The D2I is focusing on the development of algorithms, parameters and services, while IoT largely focuses on the ways data is created and transmitted to the algorithms. The DIGILE's task as a programme coordinator is to ensure that research results are understood, applied and adopted as part of participating companies' business practices.

Behind the D2I programme, there is an anticipation that the market for various Big Data applications and services will expand radically within the next years[25]. Hence, the objective of the *D2I programme* is to boost the international competitiveness of its partners through intelligent data processing technologies and services. The programme was launched in April 2012 and is foreseen to run for four years, with a possible one-year extension until 2016. D2I is one of the smallest programmes of DIGILE, with an annual volume of around € 12 million.

The D2I programme focuses on *big data, data reserves and user-centric service development* with the aim to develop better tools and methods for managing, refining and utilising diverse data. These again should allow the development of new innovative business models and services. The current phase of the programme focuses specifically on commercialisation aspects; multi-source data integration and assessment of business model viability and scalability.

The D2I has two work packages and seven miniecosystems. The *Proof of Concepts* work package is concerned primarily with user needs, business models and processes. *Enabling Methodologies* work package tackles with algorithms, platforms and tools needed for the processing of large masses of data. These are complemented (in a matrix) by business sector *miniecosystems,* which focus on applications in traffic, multimedia, security, industry, customer intelligence, wellness *and* forestry fields. A work package on *Forest Big Data* is focusing on traditional forest industry that is addressing the digitalization challenge. The work package aims to improve profitability in timber logistics and woodcraft.

The D2I is the only one of the DIGILE programmes that has been initiated by the DIGILE office during the SRA definition process. Normally SHOK programmes are initiated either by the member companies, or by the Board of Directors. For D2I, DIGILE office argued that there is a vast amount of scientific competence on Big Data/Open Data in Finnish research organisations, but this competence was poorly utilised by businesses. The intention was to design a programme, which would involve different kinds of participants, representing the healthcare sector, security, mechanical engineering, etc. For a majority of the participant companies, utilisation of Big Data provided a completely new business opportunity to explore.

Today D2I engages 43 companies (25 large, 20 SMEs) and 14 research organisations. Some of the large D2I programme partners are Tieto, CSC Computing, Stora Enso, Metsä Group, UPM-Kymmene, Metso Automation, Konecranes, Nokia and Ponsse. In terms of the programme's thematic coverage, D2I is exceptionally broad and cross-cutting. The programme includes (and funds) partners also from other SHOKs, such as from Salwe, FIMECC and FIBIC.

Relevance and impact of Tekes on capabilities

Tekes has played an *active and important role in the definition and launching* of SHOKs. It is by far the largest public funder of SHOKs, and its role can be considered instrumental to the operation of all SHOKs, including the DIGILE. Hence, the funding levels, rules and processes of Tekes have a great practical influence on how the SHOKs programmes develop.

[25] Finland and Data Reserves. TIVIT White Paper, 15.9.2010.

In the beginning, SHOK programmes used to have an exclusivity[26] of research topics over Tekes programmes, but this is not anymore the case. When the SHOK instrument was evaluated in 2012, the SHOK funding system was considered to be rigid, not driving enough for dynamism and renewal. As a consequence, the funding to SHOKs was turned into more competitive. Today, Tekes is seen less closely engaged in the SHOKs, and also the general funding to SHOKs has decreased since their inception.

The Strategic Research Agenda guides the substance of the SHOK research programmes. When DIGILE was preparing its SRAs, Tekes provided plenty of support by commenting their plans and providing access to background information, documents over relevant EU programmes, etc. For the content of the strategy definition Tekes did not intervene. Also later Tekes has held an (advisory member) seat in the DIGILE Board of Directors and (advisory member) seats in the Steering Groups of the programs; and hence is well aware of their research programmes, but does not actively influence the direction of research.

The DIGILE members are pleased with how their research programmes have been performing and results generated. In December 2014, DIGILE secretariat carried out a survey amongst their partners, asking about their views and intentions to continue the research collaboration. Basically all (98%) partners wish to continue and 50% of the respondents wish to increase the current budget. The role of Tekes funding is decisive to this end, as *90% of the partners state they would not engage in this research without Tekes funding.* Nearly all (95%) partners are pleased with how they have been able to utilise research results, and every fourth (25%) partner has been able to utilise the results more effectively than initially anticipated.

Experiences (positive, negative)

At the general level, one could consider that the core purpose of the D2I programme is to build and enhance the Bid Data utilisation capabilities of DIGILE partners in a strategic, systematic and coordinated manner. It has been set up to respond to identified capability needs of its partners in the Big Data area, putting attention particularly on those capability areas that require development and that will lead to concrete business solutions. What is also essential, is the joint approach to capability building – no organisation has a priority or exclusivity over the created approaches and results. The joint nature also means that the focus of development is on issues that can be easily shared and are of common interest to all – on research and development and on customer engagement capabilities in particular, while operational issues would be tackled by individual organisations alone.

Overall, the D2I programme represents a strategic, systematic and forward-looking mechanism for building innovation capabilities over a dedicated set of partners. It is perhaps one of the most capability building –oriented RDI instruments Tekes has. Its greatest limitation may be its focus only on shared capabilities.

Interviewee: Pauli Kuosmanen, CTO

Main findings of the case studies (Section 3.3)

- The case studies demonstrated a large variation in impacts of Tekes on different capability areas. In most cases, the impact of Tekes on the promotion of RDI collaboration capabilities has been very significant. The criteria and practices which Tekes is using when providing financial support to companies has encouraged in a positive way large companies to intensify cooperation with research institutes, universities as well as with SMEs. Tekes support has enabled the creation of truly interdisciplinary projects.
- In particuar product design, prototyping and testing capabilities were improved with Tekes support.
- Digile D2I programme provided one example of a strategic, systematic and forward-looking mechanism for building innovation capabilities amongst SHOK partners..
- On the other hand, Tekes support has not led to significant improvements of several capability areas, particularly those related to market, customer engagement and regulatory conformance capabilities and capabilities to raise capital.
- Based on these case studies, there are still some challenges related to the promotion of capabilities for intellectual property protection.

[26] That is, Tekes would not initiate own RDI programmes in areas that overlap with SHOK programmes.

4 Conclusions

The conclusions are based on the overall analysis of the results (see Chapter 3 above).

4.1 The role of public RDI funding and innovation activities in improving innovation capabilities

An organization's capability to innovate – its ability to constantly create better products, processes, services or even business models – comprises of a complex set of issues and processes, with enhancing and prohibiting elements. Innovation capability is also dynamic by its nature – the requirements for, and processes to utilize these capabilities may change and vary according to each situation. It is therefore little surprise that there aren't many good and commonly accepted frameworks or definitions for understanding and assessing innovation capabilities. Neither has the issue been exhaustively defined in Tekes. Hence, for the purpose of this study, we have taken elements of various approaches to best serve the context and requirements of Tekes RDI funding. In short, innovation capability can be seen as organization's ability to intelligently utilize its internal, external and shared resources for innovation purposes.

Research and exploration, experimenting and learning-by-doing are important ingredients in the innovation process, and this experience almost automatically accumulates innovation capabilities. Such elements are included in Tekes funded RDI activities, and in this respect, all Tekes RDI projects are by definition somehow contributing to innovation capabilities. The question is rather in which ways and how effectively.

This study has assessed Tekes contribution to innovation capabilities particularly in large enterprises and in research organizations. The general conclusion of the evaluation is that innovation capabilities are important and Tekes RDI funding has had a clear and significant positive impact on the overall accumulation of innovation capabilities of both types of organizations. There are differences between the types of organizations, and Tekes impact on SMEs innovation capabilities was not part of the evaluation and the overall picture is not complete without that. It is also clear that Tekes contribution to innovation capabilities is more complex issues than what can be easily assessed merely based on standard project follow-up questions. Further work needs to be done, for example to better understand Tekes impact on capabilities to industrial renewal and to system-level innovation capabilities. Several important lessons were drawn from the evaluation regarding innovation capabilities and are elaborated below to specific conclusions and recommendations.

4.2 How actors of the Finnish innovation environment have improved their capabilities in Tekes research projects

It should be noted that the impact study was focused on R&D projects of large companies and research organizations. The role of SMEs was studied in the research portfolios of large companies and research organizations. Based on the results, learning from SMEs had a remarkable effect on improvement of RDI collaboration and business environment of the large companies. On the other hand, learning from SMEs had a remarkable effect on improvement to commercialize research results and conduct research with companies.

The conclusions of the direct results and impacts of Tekes funding on capabilities of companies and research organizations are presented below.

4.2.1 Company Capabilities

Company performance: Despite the relative age and size of the respondent companies, as described in the Company Information section, 12% of respondents increased their annual revenues by more than 100%, and 18% of respondents increased their number of employees by 25% or more since receiving support from Tekes.

While these findings suggest that the respondent companies are experiencing modest growth, they are not considered high-growth companies, and in fact 35% report declining revenues, while 48% report a decrease in the number of employees at their company since receiving support from Tekes.

Importance of capabilities: Overall, the majority of respondents indicated that the capabilities we analyzed were either

of critical importance or were important to firms in their industry. This suggests that the capability measures that were selected through the literature review to assess the impact of Tekes support on companies, were appropriate and consistent with the needs of the companies analyzed.

We find that *Product design, prototyping, or testing* was identified as the capability of the greatest importance. Specifically, 64% of respondents reported that the ability to design, prototype, or test products is of critical importance to firms in their industry. This finding is in keeping with the interests of the large companies supported by Tekes, as the development of new products is one of the key criteria for their participation in Tekes programs.

*Domestic market capabilitie*s were found to be the least critical in terms of importance to firms in their industry, while still having some level of importance to the majority of respondents, This may be, in part, due to the larger, older nature of the respondent companies, which have saturated the Finnish market and are now expanding into international markets looking for growth opportunities. Companies such as these would value the ability to analyze the Finnish market to a lesser degree compared to, for example, younger, smaller companies.

Change in capabilities: Overall, since their engagement with Tekes, the majority of respondents indicated that their company's capabilities either improved or stayed the same, while very few respondents indicated a decline in their capacity to perform for any capability measure.

Product design, prototyping, or testing capability was identified as the capability for which the greatest change was reported. Specifically, 81% of respondents reported that their company's ability to design, prototype, or test products improved since receiving Tekes support.

Regulatory conformance was found to be the capability that improved the least. This may result of selection effect, as companies that receive funding and support from Tekes must undergo a rigorous application process, and only companies that meet certain criteria, including abiding by their industry's regulatory conformance standards, are selected. Therefore, it is not unexpected that the majority of these companies report their ability to meet industry regulatory conformance as unchanged since receiving Tekes support.

Similarly, it is not surprising that the *Financial resources* capability ranks relatively low in terms of improvement and relatively high in terms of staying the same. Given that most of the respondents represent large companies with existing streams of revenue, it would be unlikely that these companies would focus their energies on improving their ability to raise capital, when, for example, new product or service development, RDI collaboration, and internationalization are considered more important to their strategic goals and overall success.

Source of change in capabilities: Seventy six percent of respondents reported that the Tekes support received led, in part, to their company's improvement in their *Financial resources* capability. Conversely, Tekes support had the least impact on improving companies' *Supply chain management* capabilities.

A further exploration of the *Financial resources* capability yields interesting results. From the two sections in this report that focused on the importance of, and change in, capabilities, we find that the ability to raise capital or secure investment was reported to be of low importance, and that the ability to improve on this capability was also low. However, we find that the greatest percentage of companies identified Tekes support as the mechanism for improvement of their *Financial resources* capability when this ability did indeed improve. Further, the regression analysis, provided in Appendix J of the report, indicates that companies that reported the *Financial resources* capability to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. This exploration of the *Financial resources* capability suggests that Tekes is considered by respondent companies to have the greatest impact on improvements to the capability that is among the least important for firms, and for which the fewest companies report improvement.

The *Product design, prototyping, or testing* capability was identified as the capability of greatest importance, and the capability for which the greatest number of companies experienced improvement since receiving Tekes support. Furthermore, the regression analysis found that companies that reported the *Product design, prototyping, or testing* capability to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. In keeping with these findings, it was determined that 65% of respondent companies reported that the Tekes support received had an impact on their company's ability to design, prototype, or test products.

Further, it was determined that the *Domestic market* capability was of the lowest importance for respondents. Although companies reported modest improvements to their *Domestic market* capabilities, a noteworthy finding emerges from the regression analysis, which shows that the Tekes funding and business support provided are significant but negative predictors of improvements to company *Domestic market* capabilities. As funding and support increases, the improvements to this capability decrease.

How Tekes support impacts capabilities: Overall, we find that when companies indicated a capability was important for firms in their industry, and that they had experienced improvement in the specific capability measure, that the Tekes support is having meaningful impact and is an important mechanism for improving their capacity to perform.

We find from the regression analysis that Tekes support did not emerge frequently as a predictor of improvement in company capabilities when each capability was examined individually. However, when asked to report the impact of Tekes support on their companies' capabilities as a whole, 97% percent of respondents reported that the support they received from Tekes had a positive impact on improvements in their company's overall capabilities. Therefore, while Tekes support is playing an important role in improving companies' overall capabilities it is not significantly impacting each of the individual capabilities. Additionally, the impact attributed to the Tekes support mechanism was higher than the impact attributed to all other improvement mechanisms. Greater detail of this analysis may be found in the 'Impact of Improvement Mechanisms on Company Capabilities' and 'Regression Analysis of Company Capabilities' sections in Part 1 of this report.

To better understand how Tekes support impacts the capabilities of companies, two elements of the Tekes support were further examined:

Funding: Although all respondent companies received funding from Tekes, the amount of funding received varied depending on the scope of the funded project. However, the regression analysis indicates that the amount of funding provided by Tekes is only predictive of improvements in the ability of companies to operate efficiently. For all other capabilities measures the amount of funding does not emerge as a significant variable explaining improvements.

Respondents invested Tekes funding in people and external services to the greatest degree, while only 26% of respondents invested the Tekes funding received in equipment or technology. However, 87% of respondents cited product or service development as part of the rationale for their investment decisions. This suggests that for the respondent companies, which are typically larger and older companies, human capital is more critical than improvements to equipment or technology for the development of innovative products or services.

Collaboration – In keeping with Tekes' emphasis on collaboration, engagement with both small and medium enterprises (SMEs) and research organizations is one of the key criteria for large companies to receive Tekes funding and support. For certain capabilities, these engagements emerge as predictors of improvement, as shown in the regression analysis, meaning that the greater the degree of engagement, the greater the improvement on the capability.

These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of companies, and further bolsters the need for continued engagement with SMEs and research organizations.

4.2.2 Research Organization Capabilities

Importance of capabilities: Overall, the majority of respondents indicated that the capabilities analyzed were either of critical importance or were important to their organization.

We find that *Access to research funding* was identified by respondents as the capability of the greatest importance. Specifically, 80% of respondents reported that *Access to research funding* was of critical importance to their organization. Unlike the majority of the companies surveyed in Part 1 of this report, the research organizations surveyed in Part 2 do not generate substantial revenue that can be allocated towards research and development activities. As such, these organizations constantly seek other sources of financing to advance their research efforts, which leads to the elevated importance in the ability to leverage internal and external funding for the purposes of research.

Intellectual property protection, was found to be the capability of the least critical importance to research organizations, while still of critical importance or important to the majority of respondents,

The research organizations' capabilities were broken out into three groups: 1) capabilities pertaining to *strategic direction*, 2) those pertaining to *alliances and networks*, and 3) capabilities that pertain to *projects and the performance of research*.

Among the *strategic direction* capabilities, *Access to research funding* was found to be the most critical to research organizations. Among the *alliances and networks* capabilities, *International research participation* was identified as the most critical. Finally, of the *projects and performance of research* capabilities, *Problem solving* was deemed to be the most critical. However, it should be noted that as a group of capabilities, respondents deemed the *projects and performance of research* capabilities to be the least important for their organizations.

Change in capabilities: Overall, the majority of respondents indicated that their organization's ability either improved or stayed the same for all capabilities analyzed.

The *New research models* capability was identified by organizations as the capability for which they experienced the greatest change. Specifically, 76% of respondents reported that their organization's ability to evaluate or develop new research models has improved since receiving Tekes support.

Intellectual property protection was found to be the capability for which the fewest respondents reported improvement, and for which the greatest number of respondents indicated their abilities have remained the same, since receiving Tekes support. This is not surprising as the vast majority of respondents represent universities and research or-

ganizations, which most likely would have experience and a wealth of knowledge pertaining to intellectual property protection prior to their engagement with Tekes.

Despite having been identified in the previous section as the capability of greatest importance by research organizations, respondents reported that they experienced the greatest decline in their *Access to research funding* capabilities since receiving Tekes support. While it was not expected for all respondents to report improvements in every capability, it was also not expected that research organizations would experience the greatest decline in the capability identified as the most important.

Source of change in capabilities: Tekes support was consistently identified by respondents as a source of change for all capabilities; for each capability between 63% and 80% of respondents identified that Tekes support led, in part, to their improved capacity to perform. Additionally, and perhaps more critically, the regression analysis indicates that Tekes support, both financial and non-financial, predicts improvements in all capabilities. This means that the more support, either financial or non-financial, organizations receive from Tekes, the more their capabilities, capacity to perform, will improve.

Eighty percent of respondents reported that the Tekes support received led, in part, to their organization's improved ability to collaborate with companies on research projects. Conversely, only 63% of respondents identified Tekes support received as a source of change for their organization's improved ability to problem solve.

Again, research organizations identified *Access to research funding* as the most important capability for their organization. From the regression analysis we find that organizations that reported *Access to research funding* to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. As such, organizations that identified *Access to research funding* as being important were more likely to identify Tekes as the source of their improvement in this capability. This explains why, of the respondents that identified *Access to research funding* to be important and also experienced improvement in this capability, 76% reported that it was the Tekes support received which led, in part, to their organization's improved ability to access internal or external research funding.

How Tekes support impacts capabilities: Overall, Tekes support was identified as one of the key sources of improvement for all capabilities. To better understand how Tekes support impacts the capabilities of research organizations, three elements were further examined:

Funding: Ninety-nine percent of respondents reported that the financial support they received from Tekes had a positive impact on their company's overall capabilities. It was determined that the impact research organizations' attributed to the *Tekes financial support* mechanism was higher than the impacts attributed to all other improvement mechanisms.

Additionally, while all respondents received funding from Tekes, the amount of funding received varied depending on the scope of the funded project. The regression analysis indicates that the amount of funding provided by Tekes is predictive of improvements in only certain capabilities: *Identify relevant research, International journal publications, Commercialize research, International research participation,* and *International research leadership*. For these capabilities the amount of funding received predicts improvement. As such the more funding that organizations receive from Tekes the greater their improvement in these capabilities.

In keeping with Tekes' emphasis on international researcher mobility and the creation of international collaborations, the greatest number of respondents indicated that the Tekes funding was allocated to cover travel expenses, followed closely by network creation.

Non-financial support: We find that the Tekes non-financial support was deemed by respondents to have the least impact on improving their overall capacity to perform.

Collaboration: In keeping with Tekes' emphasis on collaboration, engagement with small and medium enterprises (SMEs), large companies, and other research organizations is one of the key criteria for receiving Tekes funding and support. For most capabilities, these engagements emerge as predictors of improvement, as shown in the regression analysis, meaning that the greater the degree of engagement, the greater the improvement on the capability.

These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of research organizations, and further bolsters the need for continued engagement with SMEs, large companies, and research organizations.

Outcomes of Tekes support: The main purpose of the Tekes support provided to research organizations, both financial and non-financial, is to facilitate research and improve organizational capabilities. All of the capabilities examined in previous sections enable improvements to RDI activities conducted by the research organizations.

Capability improvements, made possible by Tekes funding, had significant positive impacts on organizations' overall research performance.

Specifically, 97% of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on their organization's ability to engage in relevant research.

4.2.3 Conclusions of the Tekes follow-up responses

Although the responses are not entirely comparable, research organizations assessed the organizational level impacts and/or significance of the projects greater than the large companies on average. On a general level the analysis showed that the projects have had the greatest significance in areas related to knowledge sharing, interdisciplinarity and combining different competences as wells understanding the needs of final beneficiaries of the products/services provided.

The fact that especially the companies assessed the significance of the projects in most areas below 3.0 (moderate significance), raises questions about the achieved impacts and/or the relevance of the areas in question. Moreover, a closer analysis of individual responses suggests that on average the projects impact either all the areas of none of them. It seems that companies who assess the impacts higher on some areas, area likely to assess the impacts higher on other areas as well (rather than assess the impacts higher on some areas than in others). This may suggest that the impact of the project depend on the selection of the companies, their attributes and context, rather than the content of the project itself. Companies who participate Tekes projects might be more open and motivated to learn new things than others, so that they are developing capabilities in large front using Tekes funding as one resource among others, mainly internal allocation.

Both large companies and research organizations did not attribute any significant broader impacts to the projects on average. However, this does not necessarily mean that the projects would not have any broader impacts. To build a comprehensive picture about broader impacts and spillovers of Tekes projects the dissemination of new knowledge and technologies in industry and in society must be studied by multidisciplinary methods, like interviews, citation analysis, media analysis, network analysis etc. Especially important is to observe how new practices are adopted in industry and public sector, say improving productivity by technology or creation of new services. At least, the "developing paths" studies conducted in various fields of industry have shown that Tekes has been an important nudging actor in creation of new ecosystems (see e.g. "Uusiutuvan dieselin kehityspolku" 2011; "Teollisuusentsyymeistä kansainvälisesti verkottunutta liiketoimintaa" 2012; "Peliteollisuuskehtyspolku" 2013).

4.3 Tekes influence on the generation of intellectual capital, capabilities and the development of intellectual investments

The most important way of Tekes has been the defining of the criteria for funding, but also selecting topics to fund. A central criterion for large companies has been the collaboration with SMEs and research institutions thus enforcing to networking and collaboration.

In the lack of research based classification of capabilities, targets of Tekes in improving capabilities is necessarily *ad hoc*, picking up capabilities that are stressed in national and international discussion as present day challenged. What are critical capabilities for firms depend very much on firm specific characteristics like size, business, markets, leadership, and personnel as well as "DNA" of the firm. This means that it is almost impossible to present a general list of capabilities that are necessary for renewal of all firms.

The direct impact of Tekes on capabilities of SMEs was not investigated. It is likely that the results for SMEs would differ from the results for large companies.

4.4 Meeting the objectives associated with capabilities for innovation activities, competence bases, and internationalization and networking

Overall, Tekes has succeeded well in improving different types of capabilities. On average, the highest impact was on networking, whereas the impact on internationalization activities was weak. However, the differences between impacts on various capabilities should be studied carefully and compare to general targets (like renewing industries) of Tekes. In closer consideration these differences might be important, say the relative lowness of the impact on internationalization of RDI activities might be symptom of serious defeats in skills needed in global economy.

4.5 Capabilities that facilitate structural change and economic renewal

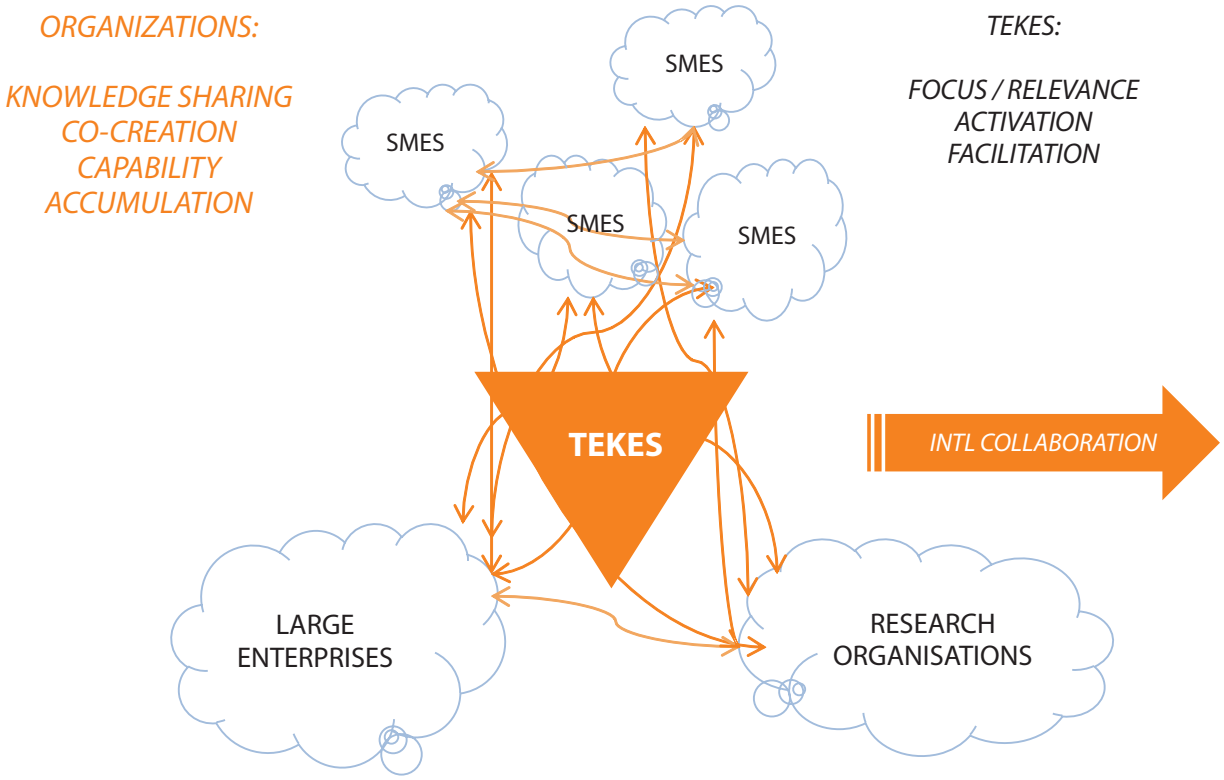
There are capabilities in many levels of organization of activities. Often capabilities are addressed mainly to single organizations or even to persons like managers. However, there are capabilities peculiar to networks, like trust and collaboration between independent organizations. Especially to build and strength business and innovation ecosystems, "network" or collective capabilities are crucial. To improve such collective capabilities, a systemic approach is needed. Many firms and research institutions are still (sub)optimising their own benefit of collaboration. Dynamic ecosystem is dependent on win-win values and practices, which emergent only in condition of trust and new forms of collective value creation.

To renew Finnish industry, a special consideration must be directed to develop leadership and business strategies. The successful business is based on global networks and on taking the position there where value capturing is most optimal to firms. This kind of strategic capability is very difficult to create and visionary leaders are rare resources in Finland. Therefor the recruiting top leaders (CEOs *etc.)* is a major asset of our firms.

The renewal of industry is a complex systemic phenomena, the elements of which include the competition in industry fields, the maturity of technology, the R&I intensity of industry, the availability of educated labour force etc. These are contextual or external elements for firms whereas firms "strategic capabilities" are their internal assets that must fit the external factors of business environment. In renewing industry many level approach is needed and different "policies" are solutions to different problems.

Figure 29 shows that capabilities are promoted at different levels from a project to programme level. Finally, the capabilities are strengthened at the systemic level. These capabilities are needed for structural change and renewal.

Figure 29. The role of Tekes in promotion of capabilities at different levels.



5 Recommendations

As our study demonstrates, Tekes has had, has, and will have an important role in creation and development of capabilities in firms as well as in universities and research institutes. This takes place setting selection criteria for projects and programs, initiating and financing domestic and international collaborative projects and programs, providing expertise and assistance to firms, research organizations and public service providers to design and implement their R&D and innovation projects, assisting innovation and research communities to internationalize and build networks etc. The role of Tekes with its wide fabric of support mechanisms and expertise is not to replace the role and activities of firms and research organisations in building capabilities. Tekes' role is to catalyze, complement and also to provocate these organization in the capability building of their own.

Recommendation 1. Refining the concept and objectives of innovation capability building for the specific purposes of Tekes

We recommend that the following categorization could be used a basis for the refining the concept of innovation capability (see also Recommendation 5).

The distinction between first order and second order capabilities is a crucial one, because second order (meta) capabilities are building in developing first order capabilities. The second order capabilities are perhaps more important for renewing practices and strategies of firms because they are generic applicable to several issues.

It is important to stress the term "dynamic" in the concept of dynamic capability, because it means the capacity to renew competences so as to achieve congruence with

Table 23. Categorization of capabilities.

Capability area	1st order capability (Tekes questions)	Tekes impact, based on study	2nd order capability (typical examples)
A. Business intelligence, strategy and positioning in the market	Understanding client needs Anticipating markets Strategic business management	Identify relevant research +++ Commercialisation of research results +	Interactive customer engagement models Utilising open data for market intelligence
B. Knowledge and competence development	Adopting information and knowledge Combining technical and non-technical expertise (within the organization)	Problem solving + Access to experimental resources +	Transition into co-creation / open source / open data approach
C. Efficient and flexible operations		Design research projects ++ Advance research ++	From traditional to digital / web-based business models Distributed production systems
D. Research, development and innovation	Managing the innovation process	New research models +++	From internal to open innovation mode Systematic innovation management
E. Networking and collaboration	Managing subcontractor networks Managing delivery networks	Identification of research partnets +++ National research collaboration +++ International research leadership +/-	Active engagement with research and other types of organisations Participation in ecosystems
F. Intellectual properties and management of intangibles (incl. Design, Branding, Promotion)	Promoting innovations	IP protection+/- Disseminate research results	Utilising open source programmes and platforms Enhanced design / branding strategies Web-based marketing
G. Access to growth financing and international markets	Internationalization Operating in international markets	International research participation ++ Access to research funding ++	New kinds of funding & revenue models (crowd funding,…) Leveraging EU programmes Access to global value chains

the changing business environment (Teece, Pisano & Shuen 1997). So the list of specific capabilities indicates the dimensions of renewing, but the most important target is to improve dynamic capability, which is a kind of generic or meta capability.

Recommendation 2. Focusing on the areas and means, through which Tekes has a clear added value

The major area for Tekes to add value to its client is networking. The new research in the field of management is stressing the central role of networking in successful business, even more than "internal" capabilities of firm. Networking is not only collaboration between firms or between firm and research institutions, but more about "managing" networks, orchestration of resources in networks, and collecting groups of actors providing complementary capabilities. In networking firms benefit from the capabilities of their partners. Tekes has been good at enhancing networking and developing new tools for networking, especially in international context. This will be a major asset of Tekes in the future, too.

Tekes should improve its own capability to identify relevant capabilities for renewing industry. Tekes needs also to deepen its knowledge about mechanism of capability creation and transfer.

To maximize its impact on companies, Tekes should take a more targeted support approach based on attributes and company needs. This again speaks for? the requirement of Tekes to truly understand the goals and objectives of its client companies, and to tailor its support and service offerings to meet their specific needs.

To enhance its overall impact on improvements to research organizations' capabilities, Tekes should refocus its energies on helping organizations improve capabilities that are identified by respondents as more important. Tekes could maximize its impact on research organizations by directing activities and support towards improving the *Strategic direction* and *Alliances and networks* capabilities, which are deemed to be more important by research organizations.

The findings suggest that Tekes should review its activities and support services designed to improve *Access to research funding* capabilities to ensure that the support available appropriately meets the needs of research organizations. Improving the ability of research organizations to leverage internal and external research funding represents an excellent opportunity for Tekes to increase its attributed impact on these organizations.

It is recommended that Tekes undertakes a thorough review of its non-financial support initiatives and programs to ensure that they are having the desired impact on the capabilities of research organizations. This again speaks to the requirement of Tekes to truly understand the goals and objectives of research organizations it works with, and tailor its support and service offerings to meet their specific needs. To maximize its impact on research organizations, Tekes should take a more targeted support approach based on objectives and organizational needs.

Furthermore, it is recommended that Tekes continues to encourage research organizations to develop their own networks through engagement with companies, both large and small, as well as with other research organizations. For the majority of the capability measures, the regression analysis showed research organization engagement with companies or other research organizations, enabled through Tekes support, to be a significant predictor of capability improvements. This suggests that there is a multiplier effect, wherein the benefits from the Tekes support can be increased when research organizations leverage this support to engage with other parties and expand their network.

Recommendation 3. Recommendations Pertaining to SME Capabilities

Tekes should undertake a separate analysis of the capability needs and support mechanisms for SMEs. One megatrend in global business is the emergent of horizontal structures, where value is created in networks of SMEs. This does not mean that large international companies are losing their traditional markets, but it means, that new SMEs are creating new markets by radical innovation and immaterial capital. The emphasis of public interventions should be in SMEs, not in large companies.

A segmentation of SME's is important for successful development of capabilities. There are at least three different categories of SMEs: start-ups, growth companies and more traditional firms (like those in machinery industry). Although start-ups and growth companies are new in the agenda of industrial policy, the need for renewal of traditional SMEs is particularly urgent and important, say for jobs. The questions of capability building are quite different in these segments so that Tekes should use specified tools to help them.

Recommendation 4. Emphasis on system level capability building, with the focus on economic renewal

The role of Tekes is to act as an agent of change. Therefore, it is important to promote the second-order dynamic capabilities which are needed for renewal *(See the figure above in Conclusions, and Recommendation 1)*. It is important not only to improve the know-how, but also to improve the capability to make better and stable changes. The renewal should be further investigated and defined in more detail. It should be noted that the capabilities e.g. new business models and internationalization needed for renewal differ case by case.

The ecosystem approach to business and innovation has opened new insight on how to create dynamic networks in local, national and global levels. One of the major means to create innovation ecosystem is to eliminate "network deficiency", that is to facilitate networking and bringing different actors to collaborate by intermediary organizations and "matching services".

Recommendation 5. Development of continuous monitoring, measurement and indicators for to support capabilities for innovation activities

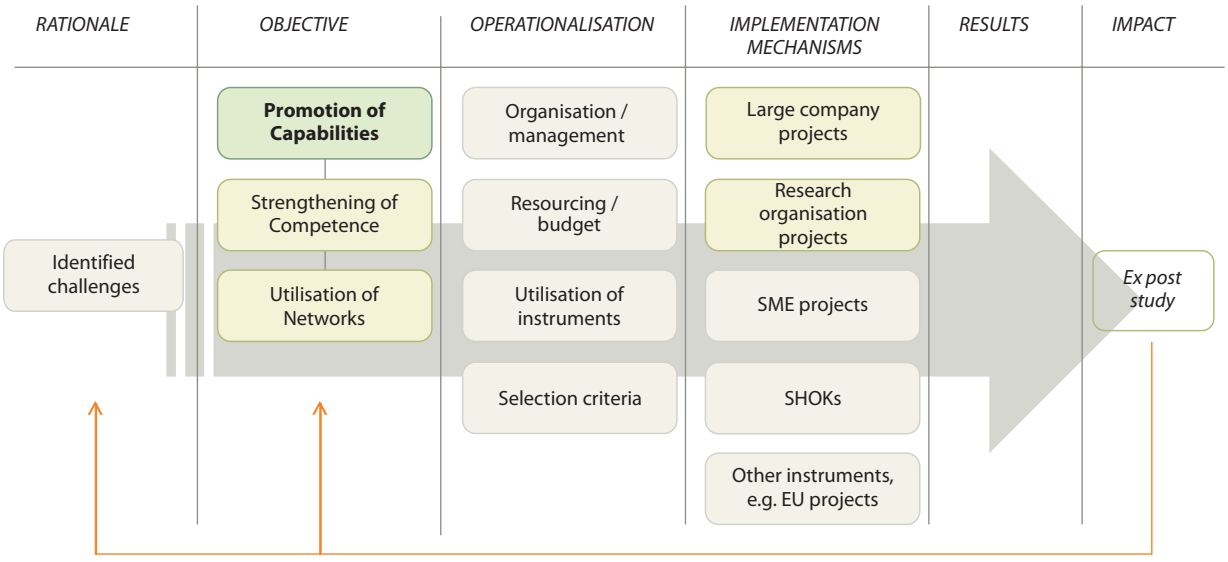
To evaluate the impact of Tekes activities on capabilities new indexes and measurement instruments like valid questionnaires has to be developed. The development of capabilities should be linked with the strategy and focus of Tekes. The critical question is: what is the problem to be solved with capabilities *(see also Recommendation 1)*. Capabilities are difficult to measure as such; instead improvement of capabilities must be evaluated in relation to changing practices; say, improvement in IPR protection must be reflected in the activity to protect IPR.

Tekes' present three years follow-up survey is not suitable for evaluation of impacts on capabilities. The follow-up survey should be further developed so that the survey should focus more on direct and organizational level impacts. For example, the question of impacts on the industry or society is very complex and extremely difficult – if not impossible – for companies and research organizations to assess. Analysing the broader impacts would require the utilization of other research methods and approaches. In addition, as with the organizational level impact areas, it is not expected that a project could impact all assessed areas. Therefore a more project specific assessment of broader impacts is needed. In general, spillovers of investments on knowledge and capabilities could be seen and evaluated mainly in long-range base, and hardly to be realized of individual projects.

Recommendation 6. Tekes funding for R&I institutions, especially for universities, is crucial for enhancing the commercialization of research results

The research funding of universities by state budget (financing model) or by the Academy of Finland is used mainly to basic research the target of which is to create new knowledge measured by academic criteria. This financing is not easy to use to applied research aiming solving practical problems of firms and society. Tekes projects are practically only ones in which universities can direct their resources to collaboration with firms or to commercialization of new knowledge. It is important to note that in the age of economic regression firms are not able or willing alone to invest in collaboration with universities in R&D. Therefore Tekes could enhance considerably the academy-industry-collaboration leading to win-win type co-creation of new knowledge and innovation. The co-creational model of knowledge creation is also breaking the barriers between basic research and applied research and thus giving new motives for researcher to collaborate with firms.

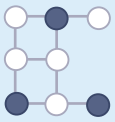
Figure 30. Promotion of capabilities in the context of Tekes.



Appendix 1.
An Assessment of Tekes Activities on Company and Research Organization Capabilities

By

The Evidence Network
www.theevidencenetwork.com



THE EVIDENCE NETWORK
Measuring Innovation Impact

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Introduction

This document provides an independent, third-party assessment of the impact of Tekes on companies and research organizations capabilities. The assessment was conducted by Ramboll Management Consulting (RMC) and The Evidence Network (TEN) during the period October – November 2014.

Tekes is Finland's main funding organization for research, development, and innovation. It promotes the development of innovation activities in research communities, industry, and service sectors through its services and its technology development, innovation, and growth funding. This helps to renew industries, increase value-add and productivity, improve the quality of working life, as well as boost exports and internationalization, and generate employment and wellbeing for Finnish companies and organizations.[1]

In an effort to add value to the innovation ecosystem, Tekes funds high quality, scientific research projects that have possible applications in business or society, as well as those with significant novelty value. The research may focus on technology, services, business or working life. The funding emphasizes extensive projects with close international cooperation that bring together research groups or specific fields of science.

As a complement to the funding activities of Tekes, business support services are also provided to companies and research organizations.

Both the funding and support provided by Tekes are aimed towards engendering the capabilities needed to generate innovations; as successful innovation activities require the strengthening of internal competencies and the effective utilization of external networks.

In an effort to assess the role of Tekes support on the capabilities of companies and research organizations, TEN and RMC developed a customized questionnaire for companies and a customized questionnaire for research organizations. The impact surveys were developed based on TEN's impact assessment methodology (see Appendix A), and were informed by an extensive literature review to determine specific measures applicable to both target groups. Fifteen capabilities measures were identified for companies, and 19 capabilities measures were identified for research organizations.

On 28 October 2014, an email was sent on behalf of Tekes, inviting 558 companies that had engaged with Tekes to participate in a web-based survey. After five email reminders, 205 client companies responded to the survey for a response rate of 37%. Further data on the response profile of respondent companies is provided in Appendix E.

On November 6th 2014, an email was sent on behalf of Tekes inviting 1163 research organizations that had engaged with Tekes to participate in a web-based survey.[2] After four email reminders, 583 research organizations responded to the survey for a response rate of 50%. Further data on the response profile of respondent companies is provided in Appendix E.

TEN and RMC took a three-pronged approach to assess the impact of Tekes support on both companies and research organizations. First, the relative importance of the various capabilities were assessed, followed by an assessment of the change experienced for each capability. Finally, respondents were asked to identify the mechanisms, Tekes support or other factors, which would impact the capabilities of companies or research organizations.

This report is presented in three sections. The first section provides a summary of the literature review conducted to develop the specific capabilities measures for both companies and research organizations. The two sections that follow are divided into two parts. Part 1 of the report is an assessment of Tekes impact on company capabilities, and Part 2 of the report is an assessment of Tekes impact on research organization capabilities.

Appendices provide TEN's impact assessment methodology, details on the response profile of participant companies and research organizations, examples of questions, additional 'other' responses, regression analysis model results, and a glossary of terms.

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1 Sourced from Tekes website: http://www.tekes.fi/en/tekes/strategy/

2 In this report, reference is frequently made to the impact of Tekes on research organizations. This terminology is used in the interests of brevity. In this report, research organizations may refer to individual researchers, a university representative, or a research organization that has been engaged with Tekes and received support.

Part I

Company Capabilities

Introduction

This section of the document provides an independent, in-depth assessment of Tekes activities and support on company capabilities. The assessment was conducted by Ramboll Management Consulting (RMC) and The Evidence Network (TEN) during the period October - November 2014, and focused on larger companies operating in Finland.

The R&D efforts of large companies may be funded by Tekes when new skills or cooperation patterns are required, or when companies are reinventing themselves to achieve an essential change in their position in the global value network. To this end, Tekes funds large companies mostly through research projects that enable them to acquire the expertise they need. If Finland does not provide the expertise companies need through incentives similar to those of other countries, or if the Finnish cooperation culture does not work, Finland will lose competitiveness.

Moreover, if large companies move the development of their core expertise outside of Finland, the other operations of these companies are also likely to follow in due course. Therefore, public funding of challenging R&D and business development activities of large companies is extremely important to Finland, as much as it is to the companies themselves.

In an effort to better understand what drives improvement to company capabilities, a customized questionnaire was developed based on TEN's impact assessment methodology (see Appendix D) and key elements of the literature review (as described in the previous section).

On 28 October 2014, an email was sent on behalf of Tekes, inviting 558 companies that had engaged with Tekes to participate in a web-based survey. After five email reminders, 205 client companies responded to the survey for a response rate of 37%. Further data on the response profile of respondent companies is provided in Appendix E.

The next section of this report provides information on the client companies in the sample. In the seven sections that follow, we provide analyses of companies' performance, the importance of companies' capabilities, the change in companies' capabilities since engagement with Tekes, the sources of change in companies' capabilities, the impact of improvement mechanisms on companies' capabilities, analyses of investment allocations and rationale, and high-level regression analysis findings. In the final section we conclude with recommendations for continuous improvement.

Appendices provide TEN's impact assessment methodology, details on the response profile of participant companies, examples of questions, additional 'other' responses, regression analysis model results, and a glossary of terms.

Company Information

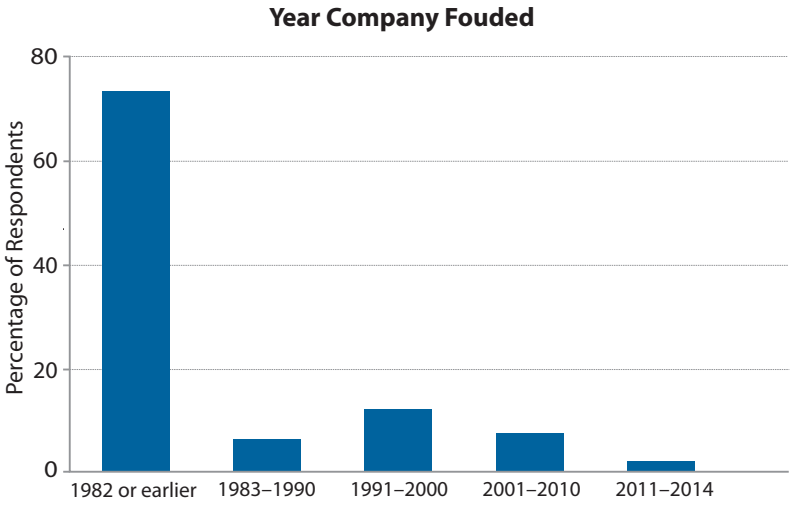
The findings indicate that respondent companies are typically older and larger with headquarters in the Uusimaa region. Seventy-three percent (73%) of respondents were founded in 1982 or earlier and 60% of respondents employ 500 people or more.

Further, 38% of respondents invest over €10 million in research, development, or innovation (RDI). This ability to invest large sums in RDI is in keeping with the age and size of most respondent companies, as older, larger companies have a greater capacity to make significant financial investments in areas such as RDI.

We begin by providing descriptions of the companies that responded to the survey in terms of the year companies were founded, headquarters location, employee demographics, annual revenues, annual investment in research, development, or innovation (RDI), and companies' industrial sector.

For the purposes of Part 1 of the assessment we refer to all companies that responded to the survey as respondents.

Figures describing the surveyed companies follow, each accompanied by the corresponding survey question, number of respondents (n), and analysis findings.

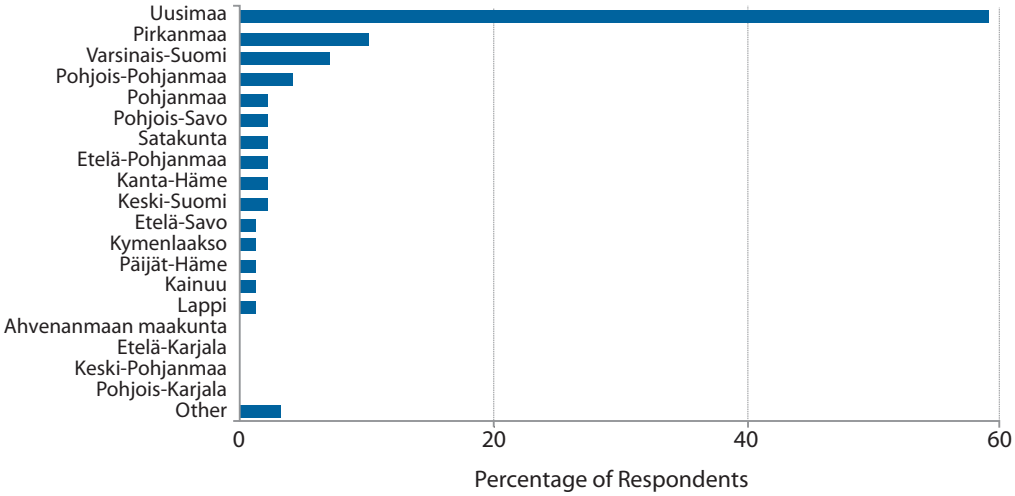


When was your company founded? n=185

Findings:

- 73% of respondents reported that their companies were founded in 1982 or earlier.
- 9% of respondents reported that their companies were founded in 2001 or later.

Headquarters Location

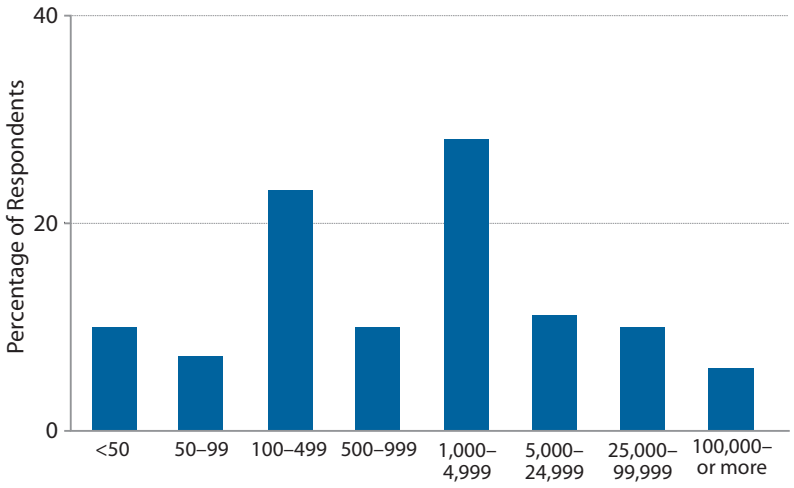


Where are your head-quarters located?[3] **n=182**

Findings:

- 59% of respondents reported that their company has headquarters in the Uusimaa region.

Number of Employees



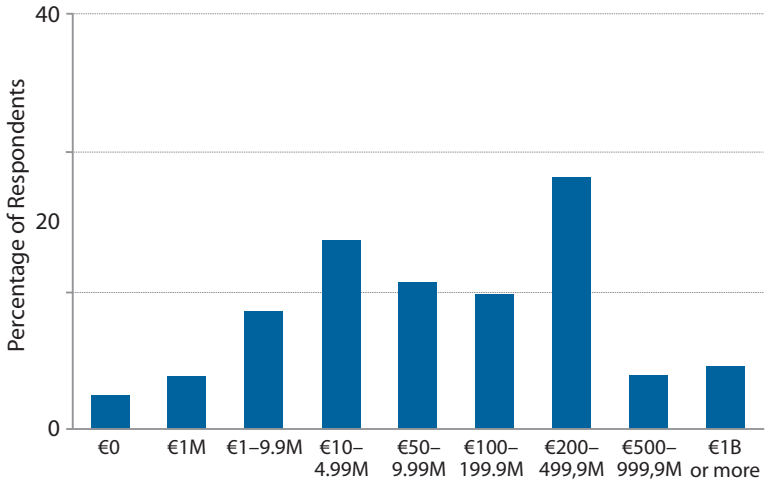
How many people (full time equivalents) are employed by your company? n=183

Findings:

- 60% of respondents reported that their company employs 500 or more full time employees.
- 28% of respondents reported that their company employs between 1,000 and 4,999 full time employees.
- 23% of respondents reported that their company employs between 100 and 499 full time employees.

[3] Respondents that identified 'Other' headquarters locations were given the opportunity to provide a literal response. These responses may be found in Appendix H.

Companies' Annual Revenues

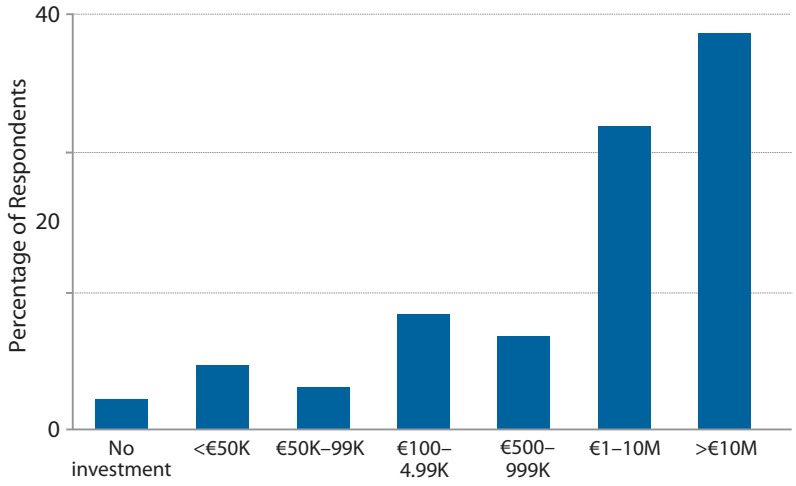


What are the annual revenues of your company? n=148

Findings:

- 35% of respondents reported that their company has annual revenues of €200 million or more.
- 24% of respondents reported that their company has annual revenues of between €200 million and €499.99 million.
- 18% of respondents reported that their company has annual revenues of between €10 million and €49.99 million.

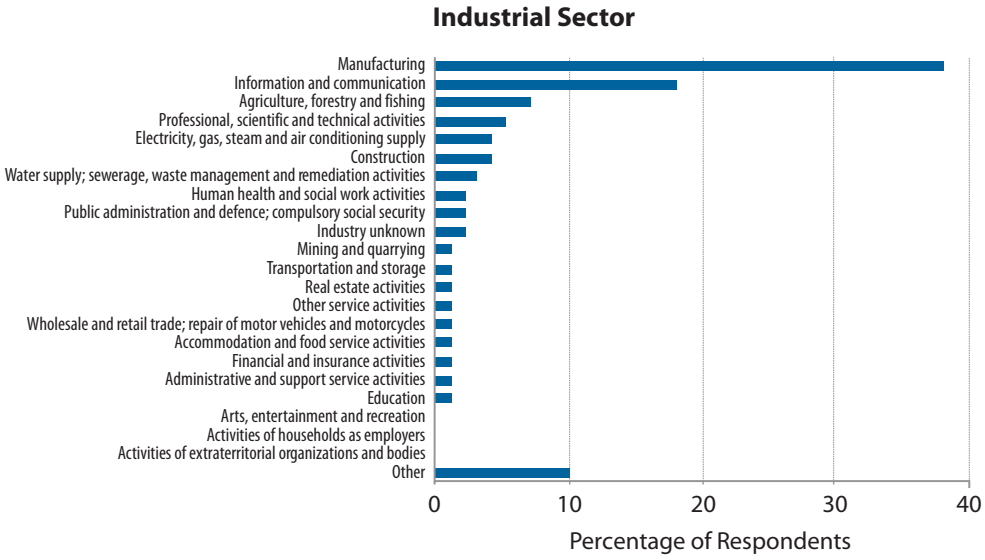
Annual RDI Investments



How much does your company invest in research, development, or innovation (RDI) annually? n=175

Findings:

- 38% of respondents reported that their company annually invests more than €10 million in research, development, or innovation (RDI).
- 29% of respondents reported that their company annually invests between €1 million and €10 million in research, development, or innovation (RDI).
- 21% of respondents reported that their company annually invests less than €500K in research, development, or innovation (RDI).
- 3% of respondents reported that their company makes no annual investment in research, development, or innovation (RDI).



In which industrial sector does your company operate?[4] **n=187**

Findings:

- 38% of respondents reported that their company operates in the manufacturing industry.
- 18% of respondents reported that their company operates in the information and communications industry.

Company Performance

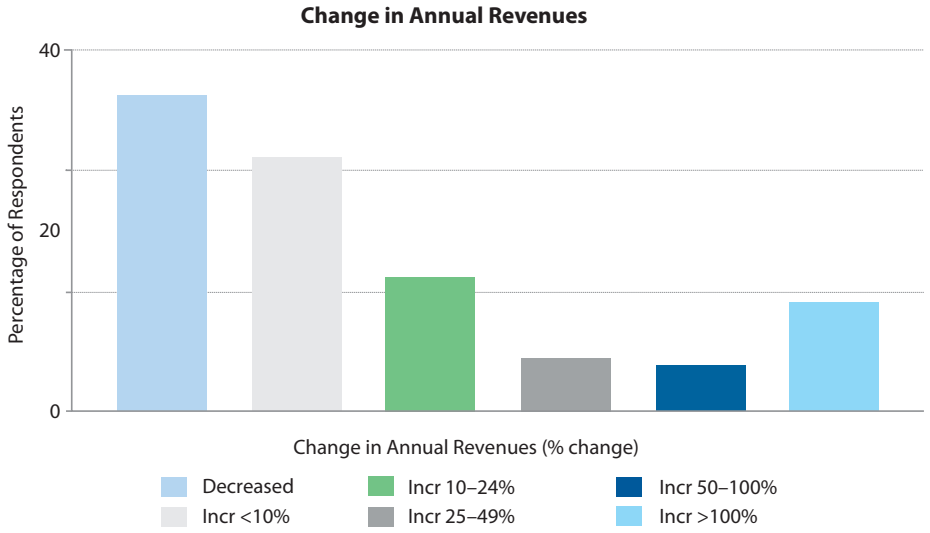
Despite the relative age and size of the respondent companies, as described in the previous section, 12% of respondents increased their annual revenues by more than 100%, and 18% of respondents increased their number of employees by 25% or more since having received support from Tekes.

While these findings suggest that the respondent companies are experiencing modest growth, they are not considered high-growth companies. Thirty-five percent of companies report declining revenues and 48% report a decrease in the number of employees at their company since having received support from Tekes.

This section provides information on the market performance of the surveyed companies. The measures are *Change in employment* and *Change in annual revenues*.

Figures describing the surveyed companies follow, each accompanied by the corresponding survey question, number of respondents (n), and analysis findings.

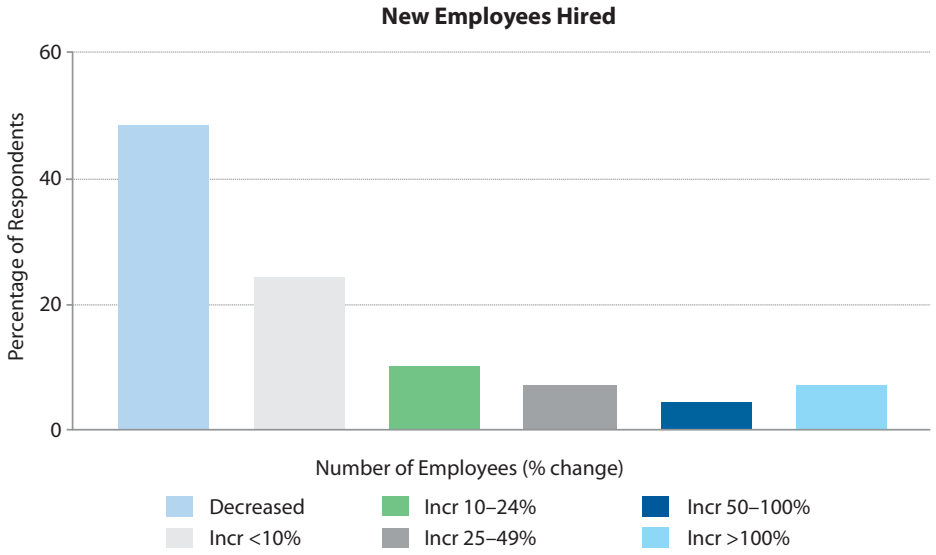
[4] Respondents that identified 'Other' industrial sectors were given the opportunity to provide a literal response. These responses may be found in Appendix H.



By how much have your company's annual revenues changed since receiving support from Tekes? n=181

Findings:

- 28% of respondents reported that since receiving support from Tekes, their company has increased annual revenues by less than 10%.
- 12% of respondents reported that since receiving support from Tekes, their company has increased annual revenues by more than 100%.
- 35% of respondents reported that since receiving support from Tekes, their company's annual revenues have decreased.



By how much has employment at your company changed since receiving support from Tekes? n=180

Findings:

- 24% of respondents reported that since receiving support from Tekes, the number of employees at their company has increased by less than 10%.
- 18% of respondents reported that since receiving support from Tekes, the number of employees at their company has increased by 25% or more.
- 7% of respondents reported that since receiving support from Tekes, the number of employees at their company has increased by more than 100%.
- 48% of respondents reported that since receiving support from Tekes, the number of employees at their company has decreased.

Importance of Capabilities for Companies

For all capabilities, the majority of respondents indicated that the capability was either of critical importance or was important to firms in their industry. This suggests that the capability measures selected to assess the impact of Tekes support on companies were appropriate and consistent with the needs of the companies analyzed.

Product design, prototyping, or testing was identified as the capability of the greatest importance. Specifically, 64% of respondents reported that the ability to design, prototype, or test products is of critical importance to firms in their industry. This finding is in keeping with the interests of the large companies supported by Tekes, as the development of new products is one of the key criteria for their participation in Tekes programs.

Domestic market capabilities were found to be the least critical in terms of importance to firms in their industry, while still having some level of importance to the majority of respondents. This may be, in part, due to the larger, older nature of the respondent companies, which have saturated the Finnish market and are now expanding into international markets looking for growth opportunities. Companies such as these would value the ability to analyze the Finnish market to a lesser degree compared to, for example, younger, smaller companies.

In order to better understand the needs of the respondent companies, they were all asked to indicate how important each capability was for firms in their industry. As such, this section provides information on the reported importance of each of the 15 capabilities measures, as identified by the respondent companies.

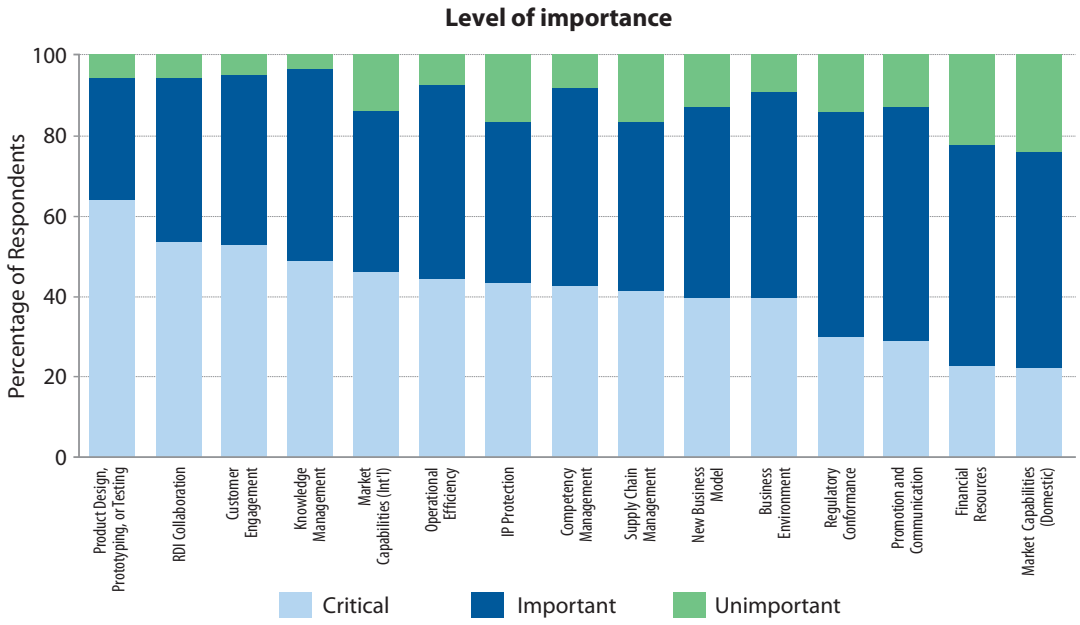
The table below shows the 15 measures, and their associated examples, which were selected to assess companies' capabilities. A frequency distribution displaying the level of importance of each capability is shown below, followed by an analysis of findings including the number of respondents (n) for each capability assessed.

Capabilities measures.

Capabilities Measure	Examples
Product design, prototyping, or testing	Design, test, or pilot new products, processes, or services, through the use of specialized equipment, software, technology, etc.
Customer engagement	Connecting with existing or potential customers and end users to elicit information or feedback on how your company's products, processes, or services can be improved to address unmet market or societal needs.
RDI collaboration	Capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.
Knowledge management	The management of new knowledge or information related to, for example, technology, products, processes, or services hat helps to accelerate your company's strategies.
Market capabilities (international)	Gathering intelligence (such as market studies, e.g. with other Team Finland partners) relevant to your company's markets outside Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Operational efficiency	Improvements to the efficiency of your organization's human resources, fixed assets or service acquisitions, financial investments, process-related, or other business practices.
Intellectual property protection	To ensure the protection or management of intellectual property, such as the use of patents, industrial design rights, trademarks, copyrights, process innovations, trade secrets, or rapid product creation and deployment, etc.
Competency management and development	Acquiring and retaining human resources (i.e. hiring new employees), developing and managing existing competences, utilizing external competences, etc.

Capabilities Measure	Examples
Supply chain management	The design, planning, execution, control, or monitoring of supply chain activities with the objective of creating added value, building a competitive infrastructure, and leveraging logistics, while managing the flow of goods and services through your supplier networks.
New business model	Evaluate, develop, test, or adopt new business models to augment or change your company's value proposition, transform your revenue- generating model, improve cash flow, etc.
Business environment	Scanning (assembling information), or networking with industry professionals, customers, suppliers, partners, industry associations, etc. to stay abreast of technological changes, customers' needs or requirements, new methods or processes, trends, or other changes in your company's business environment.
Regulatory conformance	Capabilities to stay abreast of industrial standards, regulations, laws or legislation, or other conformance requirements.
Promotion and communication	The capacity to increase visibility or raise awareness of your company's products, processes, or services (e.g. digital marketing, participating at networking or partner events, media outreach, etc.).
Market capabilities (domestic)	Gathering intelligence (such as market studies etc.) relevant to your company's markets within Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Financial resources	Capabilities to raise capital through public or private sources, or secure investments in equipment or technology to support, for example, the development of new products, processes, services, or market expansion, etc.

To what degree is (capability) important for firms in your industry?



Level of Importance: Analysis Findings

We seek to understand the distribution of scores to validate the relative importance of the 15 company capabilities measures. We determined the percentage of respondents who reported that a given capability was of critical importance or important to firms in their industry. All respondents were asked to respond to questions pertaining to importance.

Product Design, Prototyping, or Testing

n=187

- 64% (120/187) of respondents reported that the ability to design, prototype, or test products is of critical importance to firms in their industry.
- 31% (57/187) of respondents reported that the ability to design, prototype, or test products is important to firms in their industry.

RDI Collaboration

n=186

- 54% (100/186) of respondents reported that the ability to collaborate with other organizations or firms on research, development, or innovation projects is of critical importance to firms in their industry.
- 41% (76/186) of respondents reported that the ability to collaborate with other organizations or firms on research, development, or innovation projects is important to firms in their industry.

Customer Engagement

n=192

- 53% (101/192) of respondents reported that the ability to engage customers is of critical importance to firms in their industry.
- 43% (82/192) of respondents reported that the ability to engage customers is important to firms in their industry.

Knowledge Management

n=189

- 49% (92/189) of respondents reported that the ability to manage new knowledge or information is of critical importance to firms in their industry.
- 48% (91/189) of respondents reported that the ability to manage new knowledge or information is important to firms in their industry.

Market Capabilities (International)

n=189

- 46% (87/189) of respondents reported that the ability to gather, analyze, and react to international market intelligence is of critical importance to firms in their industry.
- 41% (77/189) of respondents reported that the ability to gather, analyze, and react to international market intelligence is important to firms in their industry.

Operational Efficiency

n=187

- 44% (83/187) of respondents reported that the ability to improve the efficiency of operations is of critical importance to firms in their industry.
- 49% (91/187) of respondents reported that the ability to improve the efficiency of operations is important to firms in their industry.

Intellectual Property Protection

n=187

- 43% (81/187) of respondents reported that the ability to protect or manage their intellectual property is of critical importance to firms in their industry.
- 40% (75/187) of respondents reported that the ability to protect or manage their intellectual property is important to firms in their industry.

Competency Management and Development

n=186

- 43% (79/186) of respondents reported that the ability to manage and develop competencies, through the engagement or retention of employees, is of critical importance to firms in their industry.
- 50% (93/186) of respondents reported that the ability to manage and develop competencies, through the engagement or retention of employees, is important to firms in their industry.

Supply Chain Management

n=188

- 42% (78/188) of respondents reported that the ability to manage their supply chain is of critical importance to firms in their industry.
- 42% (79/188) of respondents reported that the ability to manage their supply chain is important to firms in their industry.

New Business Model

n=187

- 40% (74/187) of respondents reported that the ability to develop, evaluate, or adopt new business models is of critical importance to firms in their industry.
- 48% (89/187) of respondents reported that the ability to develop, evaluate, or adopt new business models is important to firms in their industry.

Business Environment

n=187

- 40% (74/187) of respondents reported that the ability to scan, or network within, their business environment is of critical importance to firms in their industry.
- 52% (97/187) of respondents reported that the ability to scan, or network within, their business environment is important to firms in their industry.

Regulatory Conformance

n=187

- 30% (56/187) of respondents reported that the ability to conform to industry regulations is of critical importance to firms in their industry.
- 56% (104/187) of respondents reported that the ability to conform to industry regulations is important to firms in their industry.

Promotion and Communications

n=188

- 29% (54/188) of respondents reported that the ability to promote their firm is of critical importance to firms in their industry.
- 59% (110/188) of respondents reported that the ability to promote their firm is important to firms in their industry.

Financial Resources

n=184

- 23% (42/184) of respondents reported that the ability to raise capital or secure investment is of critical importance to firms in their industry.
- 55% (101/184) of respondents reported that the ability to raise capital or secure investment is important to firms in their industry.

Market Capabilities (Domestic)

n=190

- 22% (42/190) of respondents reported that the ability to gather, analyze, and react to domestic market intelligence is of critical importance to firms in their industry.
- 54% (103/190) of respondents reported that the ability to gather, analyze, and react to domestic market intelligence is important to firms in their industry.

Change in Capabilities for Companies

For all capabilities, the majority of respondents indicated that their company's ability either improved or stayed the same, while very few respondents indicated a decline in their capacity to perform for any capability measure.

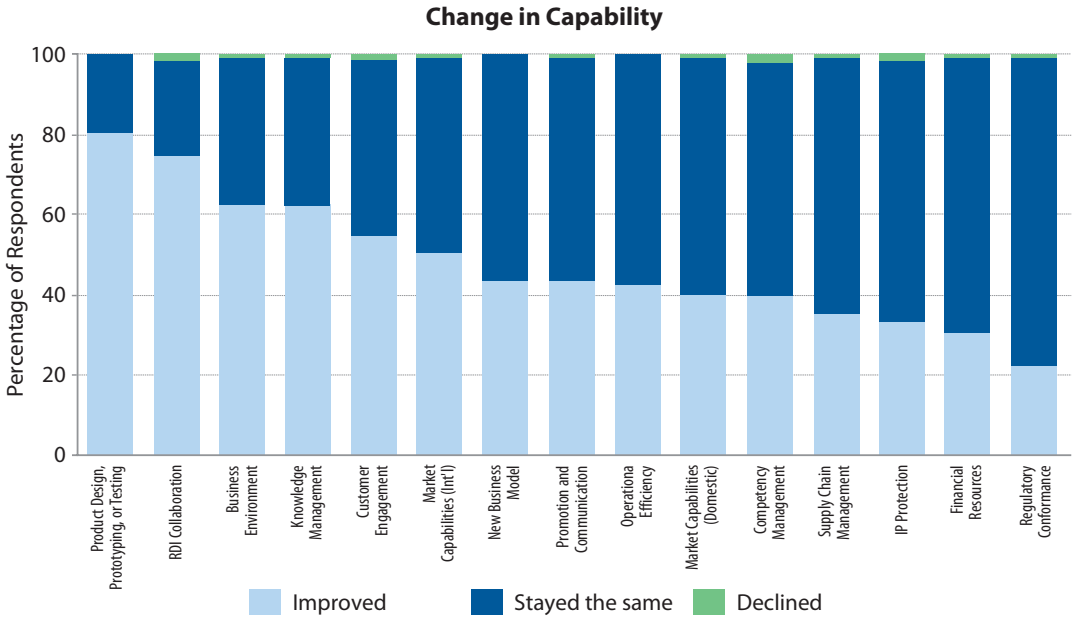
In keeping with the previous section, *Product design, prototyping, or testing* capability was identified as the capability for which the greatest change was reported. Specifically, 81% of respondents reported that their company's ability to design, prototype, or test products has improved since receiving Tekes support.

Regulatory conformance was found to be the capability for which the fewest respondents reported improvement since having received Tekes support. This is likely the result of selection bias, as companies that receive funding and support from Tekes go through a rigorous selection process, and only companies that are already abiding by their industry's regulations are accepted. Therefore we expect to see the majority of these companies remain the same with respect to their ability to conform to regulation.

Similarly, it is unsurprising that the *Financial resources* capability ranks relatively low in terms of improvement and relatively high in terms of staying the same. Given that most of the respondents represent large companies with existing streams of revenue, it would be unlikely that these companies would focus their energies on improving their ability to raise capital.

Building on the findings from the previous section, once it had been determined that a given capability was important, and therefore relevant, to respondents, they were asked to indicate their company's improvement in that capability since receiving Tekes support. The purpose of Tekes funding and support provided is to improve the capabilities of these companies. As such, we seek to understand whether the companies have improved, remain unchanged, or declined in their abilities pertaining to specific capabilities since having received Tekes support. This section provides information on the change experienced by respondent companies for each of the 15 capabilities measures. A frequency distribution showing the changes in capabilities is shown below.

Since receiving Tekes support, how have your company's (capability) changed?



Change in Capabilities Findings

We seek to understand the distribution of scores to validate the relative improvement experienced by respondent companies for each of the 15 company capabilities measures. We determined the percentage of respondents who reported improvement in each of the capabilities. Only respondents that answered 'critical importance' or 'important' to the question pertaining to the importance of a given capability were asked to respond to the associated question pertaining to the change in that capability.

Product Design, Prototyping, or Testing

n=175

- 81% (141/175) of respondents reported that their company's ability to design, prototype, or test products has improved since receiving Tekes support.

RDI Collaboration

n=174

- 75% (130/174) of respondents reported that their company's ability to collaborate with other organizations or firms on research, development, or innovation projects has improved since receiving Tekes support.

Business Environment

n=169

- 63% (106/169) of respondents reported that their company's ability to scan, or network within, their business environment has improved since receiving Tekes support.

Knowledge Management

n=181

- 62% (113/181) of respondents reported that their company's ability to manage new knowledge or information has improved since receiving Tekes support.

Customer Engagement

n=178

- 55% (98/178) of respondents reported that their company's ability to engage customers has improved since receiving Tekes support.

Market Capabilities (International)

n=162

- 51% (82/162) of respondents reported that their company's ability to gather, analyze, and react to international market intelligence has improved since receiving Tekes support.

New Business Model

n=160

- 44% (70/160) of respondents reported that their company's ability to develop, evaluate, or adopt new business models has improved since receiving Tekes support.

Promotion and Communications

n=161

- 44% (70/161) of respondents reported that their company's ability to promote their firm has improved since receiving Tekes support.

Operational Efficiency

n=172

- 42% (73/172) of respondents reported that their company's ability to improve the efficiency of operations has improved since receiving Tekes support.

Competency Management and Development

n=170

- 40% (68/170) of respondents reported that their company's ability to manage and develop competencies, through the engagement or retention of employees, has improved since receiving Tekes support.

Market Capabilities (Domestic)

n=142

- 40% (57/142) of respondents reported that their company's ability to gather, analyze, and react to domestic market intelligence has improved since receiving Tekes support.

Supply Chain Management

n=155

- 36% (55/155) of respondents reported that their company's ability to manage their supply chain has improved since receiving Tekes support.

Intellectual Property Protection

n=153

- 33% (51/153) of respondents reported that their company's ability to protect or manage their intellectual property has improved since receiving Tekes support.

Financial Resources

n=138

- 30% (42/138) of respondents reported that their company's ability to raise capital or secure investment has improved since receiving Tekes support.

Regulatory Conformance

n=157

- 22% (35/157) of respondents reported that their company's ability to conform to industry regulations has improved since receiving Tekes support.

Source of Change in Capabilities for Companies

Seventy six percent of respondents reported that the Tekes support received led, in part, to their company's improvement in their *Financial resources* capability. Conversely, the Tekes support received had the least impact on companies' improvements to their *Supply chain management* capabilities.

A further exploration of the *Financial resources* capability yields interesting results. From the two previous sections, we find that the ability to raise capital or secure investment was reported to be of low importance, and that the improvement in this capability since having received support from Tekes was also low. However, we find that the greatest percentage of companies identified Tekes support as the mechanism for improvement of their *Financial resources* capability when this ability did indeed improve. Further, the regression analysis provided in Appendix J indicates that companies that reported the *Financial resources* capability to be of greater importance attributed greater impact to Tekes on their ability to improve this capability. This exploration of the *Financial resources* capability suggests that Tekes is considered by respondent companies to have the greatest impact on improvements to this capability that is among the least important for firms, and for which the fewest companies report improvement.

The *Product design, prototyping, or testing* capability was identified in the two previous sections as the capability of greatest importance, and the capability for which the greatest number of companies experienced improvement since receiving Tekes support. Furthermore, the regression analysis found that companies that reported the *Product design, prototyping, or testing* capability to be of greater

importance attributed greater impact to Tekes on their ability to improve this capability. In keeping with these findings, in this section we found that 65% of respondent companies reported that the Tekes support received had an impact on their company's ability to design, prototype, or test products.

In the section on the importance of capabilities we also found that the *Domestic market* capability was of least critical importance for respondents. In the section on capability improvement, the *Domestic market* capability was reported to be in the mid-range of the capabilities that were improved by companies. However, a noteworthy finding emerges from the regression analysis. This analysis indicated that the Tekes funding and business support provided are significant but negative predictors of improvements to company *Domestic market* capabilities, meaning that as funding and support increases, the improvements to this capability decreases.

Overall, we find that when companies indicated a capability was important for firms in their industry, and that they had experienced improvement in the specific capability measure, that the Tekes support is having a meaningful impact and is an important mechanism for improving their capacity to perform.

Beyond the findings presented in the previous two sections, it is important to determine the role that Tekes support, as well as other improvement mechanisms, plays in improving company capabilities and their capacity to perform better. This section provides information on the sources of change for each of the 15 capabilities measures, as identified by the respondent companies.

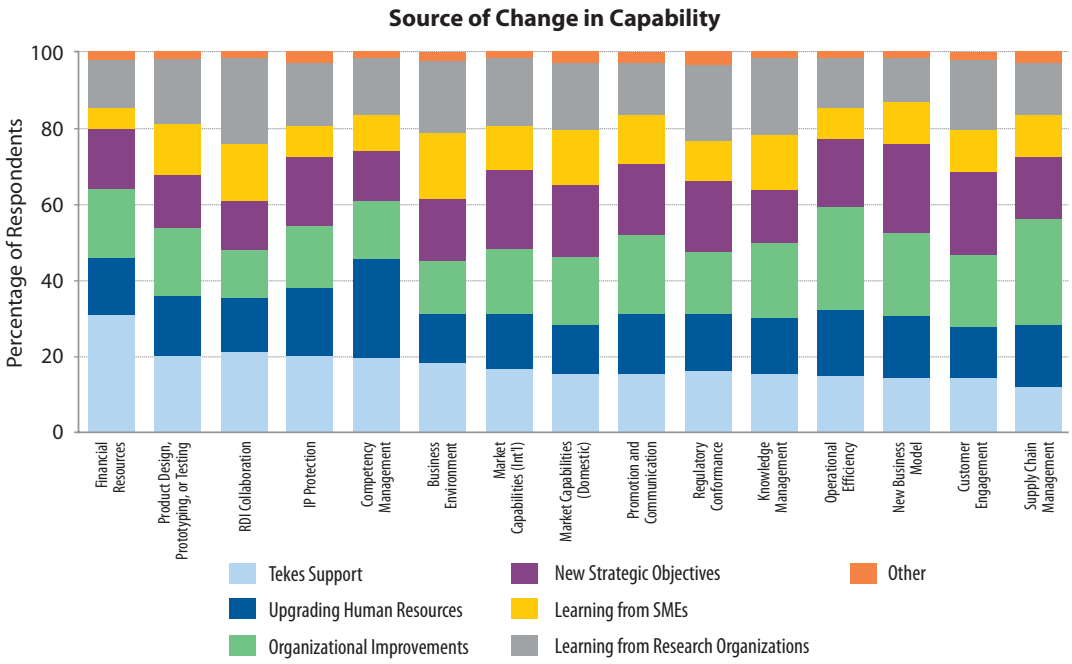
The following table shows the six improvement mechanisms, and their associated description, that were selected as sources of change for company capabilities.

Improvement mechanisms.

Improvement Mechanism	Explanation
Tekes support (financial and non-financial)	Funding and business support provided by Tekes.
Upgrading human resources	Improved in-house expertise or improved ability to leverage external expertise.
Organizational improvements	New organizational processes, equipment, or infrastructure.
New strategic objectives	Pursuit of new strategic objectives that required new capabilities.
Learning from SMEs	Insights and capabilities gained from engaging with small and medium enterprises (SMEs)
Learning from research organizations	Insights and capabilities gained from engaging with research organizations.

A frequency distribution showing the source of changes in capabilities is shown below. Respondents were invited to select all sources of change that applied to their company; this results in a greater number of responses than respondents for each question. As such, the frequency distribution presents the source of change findings as percentage of responses. However, the descriptive findings that follow are more meaningful when presented as percentage of respondents rather than responses. So while the frequency distribution and the descriptive findings do not align, they are both the clearest possible representations of the data.

Which of the following led to improvements in your company's (capability)? Please select all that apply.[5]



Source of Change in Capabilities Findings

We seek to understand the distribution of scores to validate the relative importance of each of the six improvement mechanisms for all 15 of the company capabilities measures. Only respondents that indicated improvement in a given capability were asked to respond to the associated question pertaining to the source of change in that capability.

Financial Resources

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=41) accounts for 42% of the total number of responses (n=98).

- 76% (31/41) of respondents reported that the Tekes support led, in part, to their company's improved ability to raise capital or secure investment.
- 42% (17/41) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to raise capital or secure investment.
- 39% (16/41) of respondents reported that new strategic objectives led, in part, to their company's improved ability to raise capital or secure investment.

Product Design, Prototyping, or Testing

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=141) accounts for 32% of the total number of responses (n=442).

- 65% (91/141) of respondents reported that the Tekes support led, in part, to their company's improved ability to design, prototype, or test products.
- 57% (80/141) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to design, prototype, or test products.
- 56% (79/141) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to design, prototype, or test products.

[5] Respondents that identified 'Other' sources of change were given the opportunity to provide a literal response. These responses may be found in Appendix H.

RDI Collaboration

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=129) accounts for 31% of the total number of responses (n=422).

- 74% (95/129) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to collaborate with other organizations or firms on research, development, or innovation projects.
- 70% (90/129) of respondents reported that the Tekes support led, in part, to their company's improved ability to collaborate with other organizations or firms on research, development, or innovation projects.
- 47% (61/129) of respondents reported that learnings from SMEs led, in part, to their company's improved ability to collaborate with other organizations or firms on research, development, or innovation projects.
- 47% (60/129) of respondents reported that upgrades to human resources led, in part, to their company's improved ability to collaborate with other organizations or firms on research, development, or innovation projects.

Intellectual Property Protection

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=50) accounts for 39% of the total number of responses (n=128).

- 52% (26/50) of respondents reported that the Tekes support led, in part, to their company's improved ability to protect or manage their intellectual property.
- 48% (24/50) of respondents reported that new strategic objectives led, in part, to their company's improved ability to protect or manage their intellectual property.
- 46% (23/50) of respondents reported that upgrades to human resources led, in part, to their company's improved ability to protect or manage their intellectual property.

Competency Management and Development

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=68) accounts for 33% of the total number of responses (n=205).

- 78% (53/68) of respondents reported that upgrades to human resources led, in part, to their company's improved ability to manage and develop competencies, through the engagement or retention of employees.
- 60% (41/68) of respondents reported that the Tekes support led, in part, to their company's improved ability to manage and develop competencies, through the engagement or retention of employees.
- 47% (32/68) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to manage and develop competencies, through the engagement or retention of employees.

Business Environment

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=105) accounts for 33% of the total number of responses (n=314).

- 58% (61/105) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to scan, or network within, their business environment.
- 55% (58/105) of respondents reported that the Tekes support led, in part, to their company's improved ability to scan, or network within, their business environment.
- 51% (53/105) of respondents reported that new strategic objectives led, in part, to their company's improved ability to scan, or network within, their business environment.

Market Capabilities (International)

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=82) accounts for 33% of the total number of responses (n=246).

- 63% (52/82) of respondents reported that new strategic objectives led, in part, to their company's improved ability to gather, analyze, and react to international market intelligence.

- 56% (46/82) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to gather, analyze, and react to international market intelligence.
- 54% (44/82) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to gather, analyze, and react to international market intelligence.
- 51% (42/82) of respondents reported that the Tekes support led, in part, to their company's improved ability to gather, analyze, and react to international market intelligence.

Market Capabilities (Domestic)

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=57) accounts for 34% of the total number of responses (n=167).

- 56% (32/57) of respondents reported that new strategic objectives led, in part, to their company's improved ability to gather, analyze, and react to domestic market intelligence.
- 53% (30/57) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to gather, analyze, and react to domestic market intelligence.
- 53% (30/57) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to gather, analyze, and react to domestic market intelligence.
- 46% (26/57) of respondents reported that the Tekes support led, in part, to their company's improved ability to gather, analyze, and react to domestic market intelligence.

Promotion and Communications

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=70) accounts for 38% of the total number of responses (n=185).

- 56% (39/70) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to promote their firm.
- 50% (35/70) of respondents reported that new strategic objectives led, in part, to their company's improved ability to promote their firm.
- 41% (29/70) of respondents reported that the Tekes support led, in part, to their company's improved ability to promote their firm.

Regulatory Conformance

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=35) accounts for 38% of the total number of responses (n=92).

- 54% (19/35) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to conform to industry regulations.
- 51% (18/35) of respondents reported that new strategic objectives led, in part, to their company's improved ability to conform to industry regulations.
- 43% (15/35) of respondents reported that the Tekes support led, in part, to their company's improved ability to conform to industry regulations.

Knowledge Management

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=113) accounts for 33% of the total number of responses (n=343).

- 62% (70/113) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to manage new knowledge or information.
- 59% (67/113) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to manage new knowledge or information.
- 47% (53/113) of respondents reported that the Tekes support led, in part, to their company's improved ability to manage new knowledge or information.

Operational Efficiency

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=73) accounts for 33% of the total number of responses (n=219).

- 84% (61/73) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved operational efficiency.
- 53% (39/73) of respondents reported that new strategic objectives led, in part, to their company's improved operational efficiency.
- 52% (38/73) of respondents reported that upgrades to human resources led, in part, to their company's improved operational efficiency.
- 45% (33/73) of respondents reported that the Tekes support led, in part, to their company's improved operational efficiency.

New Business Model

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=70) accounts for 33% of the total number of responses (n=211).

- 71% (50/70) of respondents reported that new strategic objectives led, in part, to their company's improved ability to develop, evaluate, or adopt new business models.
- 67% (47/70) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to develop, evaluate, or adopt new business models.
- 49% (34/70) of respondents reported that upgrades to human resources led, in part, to their company's improved ability to develop, evaluate, or adopt new business models.
- 44% (31/70) of respondents reported that the Tekes support led, in part, to their company's improved ability to develop, evaluate, or adopt new business models.

Customer Engagement

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=97) accounts for 35% of the total number of responses (n=276).

- 63% (61/97) of respondents reported that new strategic objectives led, in part, to their company's improved ability to engage customers.
- 55% (53/97) of respondents reported that learnings from research organizations led, in part, to their company's improved ability to engage customers.
- 54% (52/97) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to engage customers.
- 41% (40/97) of respondents reported that the Tekes support led, in part, to their company's improved ability to engage customers.

Supply Chain Management

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=55) accounts for 34% of the total number of responses (n=161).

- 82% (45/55) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their company's improved ability to manage their supply chain.
- 49% (27/55) of respondents reported that new strategic objectives led, in part, to their company's improved ability to manage their supply chain.
- 47% (26/55) of respondents reported that upgrades to human resources led, in part, to their company's improved ability to manage their supply chain.
- 36% (20/55) of respondents reported that the Tekes support led, in part, to their company's improved ability to manage their supply chain.

Impact of Improvement Mechanisms on Company Capabilities

Although, as we see in the regression analysis found in Appendix J, Tekes support did not emerge frequently as a predictor of improvement for company capabilities, when examined separately, 97% percent of respondents reported that the support they received from Tekes had a positive impact on their company's overall capabilities improvements.

Additionally, the impact attributed to the *Tekes support* mechanism was higher than the impact attributed to all other improvement mechanisms, except for the setting of a *New strategic objective* measure (significant at least at the 95% confidence level).

In the previous section respondents were asked which mechanisms led to improvements in each specific capabilities measure. However, it is also important to understand the role of the various mechanisms in facilitating improvements in company capabilities as a whole, rather than on a measure-by-measure basis. As such, this section provides an overview of the impact of the six mechanisms on the overall improvement to companies' capabilities.[6]

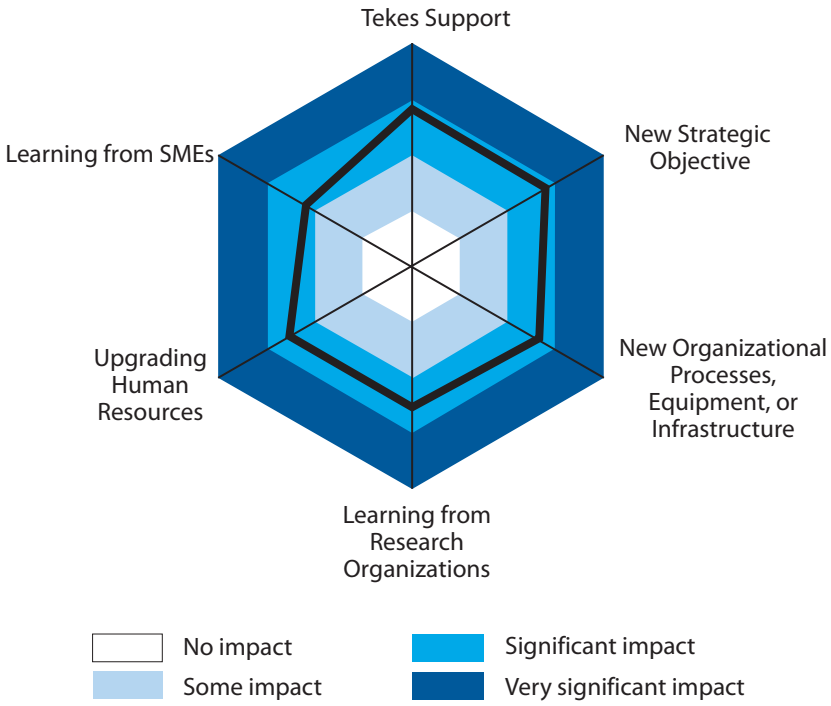
Respondents were asked to indicate the impact of each of the six improvement mechanisms on their company's overall capabilities. The following lead question was presented to respondents:

To what degree have each of the following mechanisms impacted your company's overall capabilities?

Details on our standardized question format are provided in Appendix F.

Reading clockwise in the following figure, the average impacts of the improvement mechanisms range from the high-end of 'significant impact' on improvements resulting from *Tekes support* to the low-end of 'significant impact' on improvements resulting from *Learning from SMEs*.

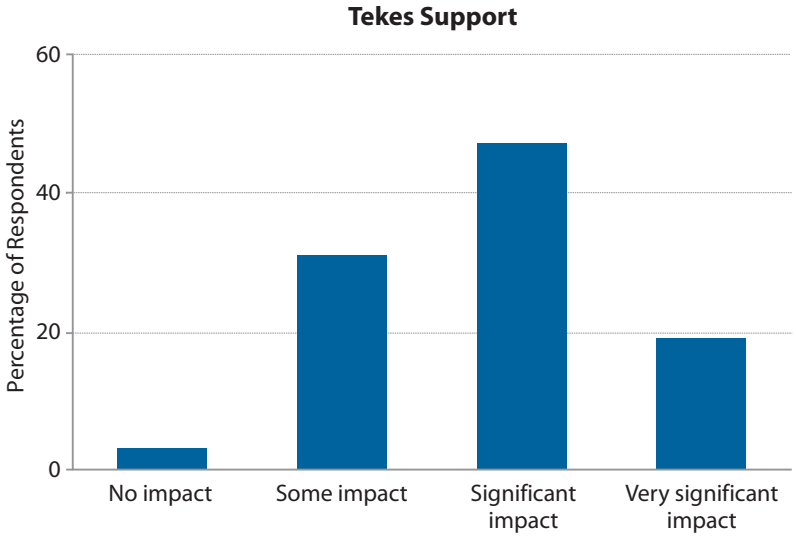
Average Impact of the Improvement Mechanisms on Companies' Overall Capabilities



6 Impact is measured on a scale using the following weights: 'No impact' 2.5, 'Some impact' 5.0, 'Significant impact' 7.5, 'Very significant impact' 10.0.

We tested for significant differences among the improvement mechanisms and found that the impacts attributed to the *Tekes support* mechanism was higher than the impacts attributed to all other improvement mechanisms, except for setting a *New strategic objective* (significant at least at the 95% confidence level).

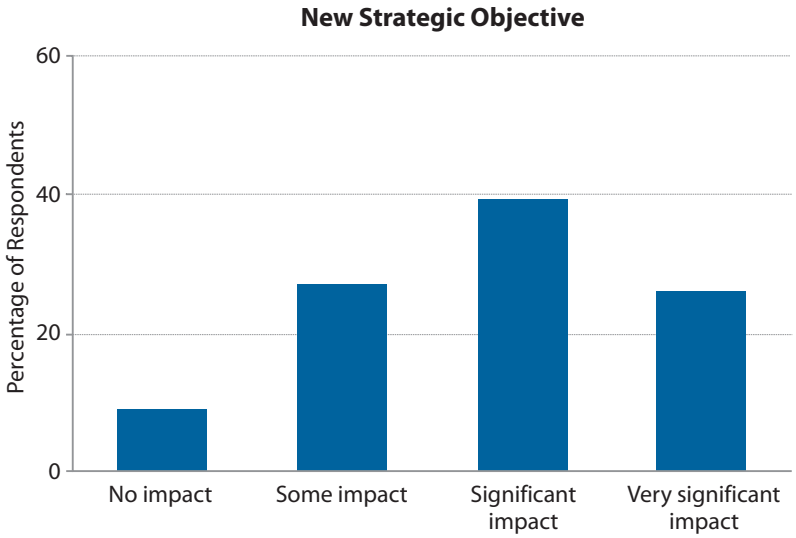
The frequency distributions that follow show impact responses for all six improvement mechanisms, together with the corresponding survey questions, number of respondents, and average impact scores (out of 10).



To what degree has the Tekes support received impacted your company's overall capabilities?
n=182
Average=7.1

Findings:

- 97% (177/182) of companies reported that the Tekes support received had a positive impact on their company's overall capabilities.

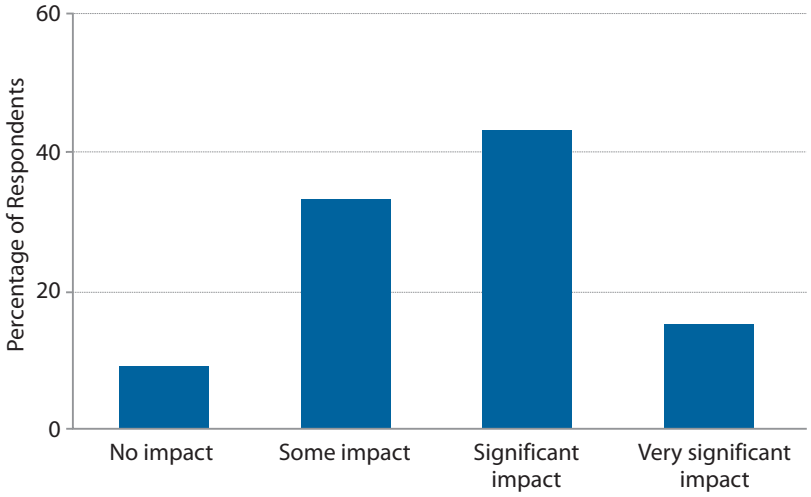


To what degree have new strategic objectives impacted your company's overall capabilities?
n=180
Average=7.0

Findings:

- 91% (164/180) of companies reported that new strategic objectives had a positive impact on their company's overall capabilities.

New Organization Processes, Equipment, or Infrastructure

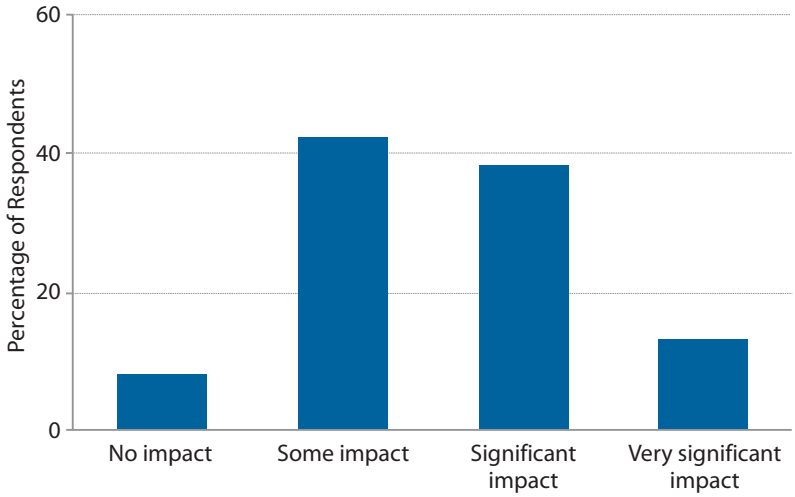


To what degree have new organizational processes, equipment, or infrastructure impacted your company's overall capabilities?
n=183
Average=6.6

Findings:

- 91% (166/183) of companies reported that new organizational processes, equipment, or infrastructure had a positive impact on their company's overall capabilities.

Learning from Research Organizations

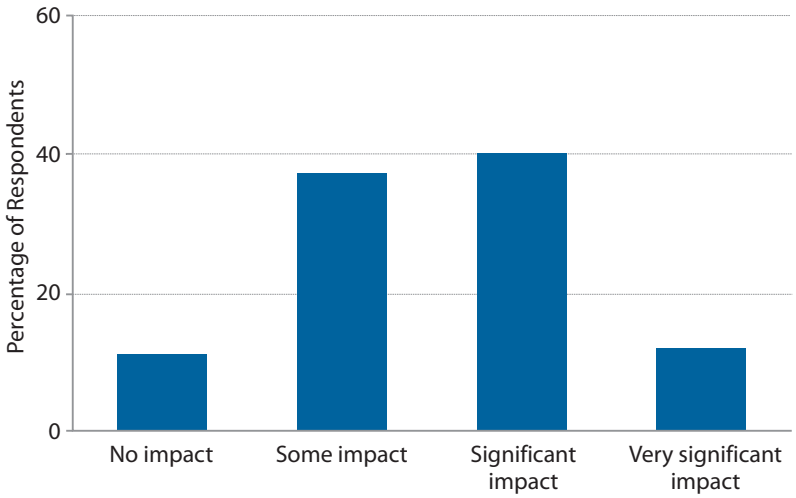


To what degree have learnings from research organizations impacted your company's overall capabilities?
n=182
Average=6.4

Findings:

- 92% (168/182) of companies reported that learnings from research organizations had a positive impact on their company's overall capabilities.

Upgrading Human Resources

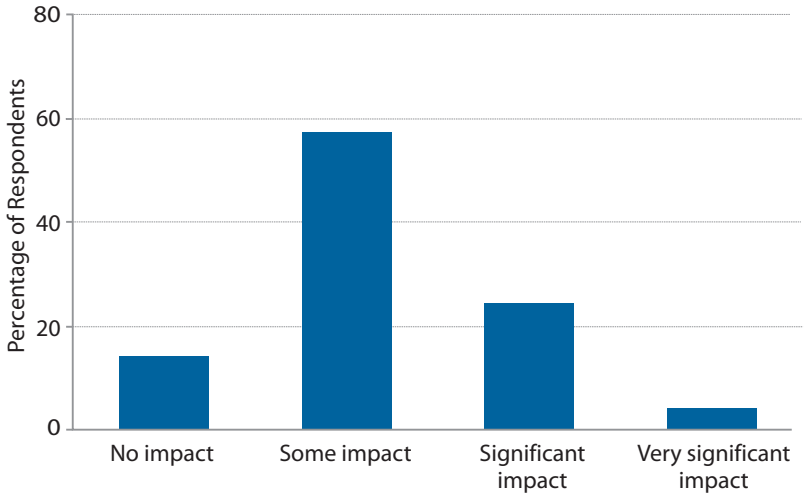


To what degree has upgrading human resources impacted your company's overall capabilities?
n=183
Average=6.3

Findings:

- 89% (163/183) of companies reported that upgrading their human resources had a positive impact on their company's overall capabilities.

Learning from SMEs



To what degree have learnings from SMEs impacted your company's overall capabilities?
n=180
Average=5.5

Findings:

- 86% (155/180) of companies reported that learnings from SMEs had a positive impact on their company's overall capabilities.

Company Engagement

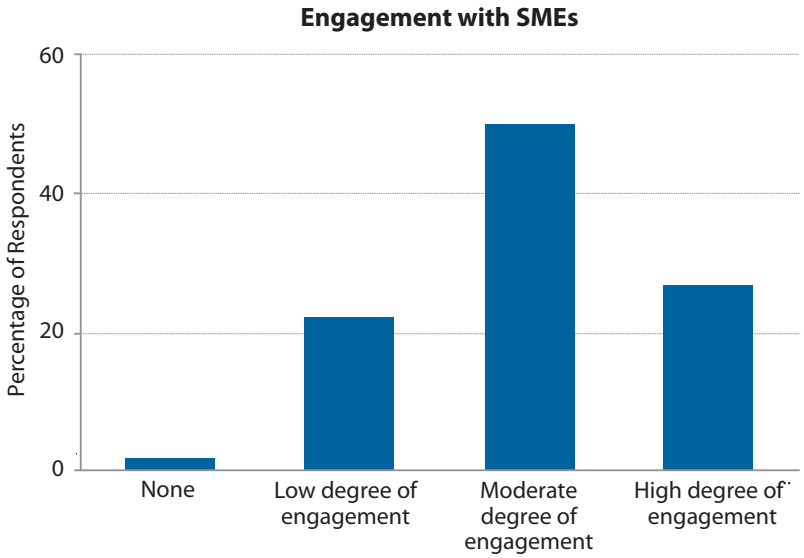
In keeping with Tekes' emphasis on collaboration, engagement with both small and medium enterprises (SMEs) and research organizations is one of the key criteria for large companies to receive Tekes funding and support. For certain capabilities, these engagements emerge as predictors of improvement, found in the regression findings in Appendix J, meaning that the greater the degree of engagement, the greater the improvement on the capability.

These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of companies, and further bolsters the need for continued engagement with SMEs and research organizations.

This section provides information on the degree of engagement of respondent companies with small and medium enterprises (SMEs), as well as their engagement with research organizations, that was consequent to Tekes support.

One of the conditions of Tekes funding for large companies is research cooperation with SMEs, research institutes, and universities. The co-operation between higher education institutions, research institutes, and companies creates expertise in Finland, and in turn keeps innovation activities of companies in the country. Large-scale global challenges also require the collaboration of large companies and their networks with SMEs.[7]

Figures describing the surveyed companies follow, each accompanied by the corresponding survey question, number of respondents (n), and analysis findings.

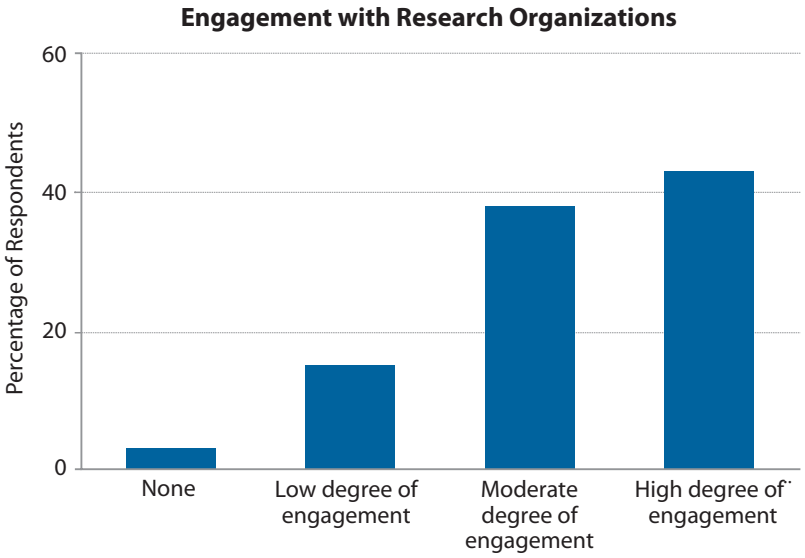


Since your first engagement with Tekes, to what degree has your company engaged with SMEs as a consequence of Tekes support? n=199

Findings:

- 76% of companies reported that they engaged with SMEs to a 'moderate' or 'high' degree as a consequence of Tekes support

[7] Taken from Tekes' Invitation to tender on the procurement of The Impact of Tekes Activities on Capabilities.



Since your first engagement with Tekes, to what degree has your company engaged with research organizations as a consequence of Tekes support? n=194

Findings:

- 81% of companies reported that they engaged with research organizations to a 'moderate' or 'high' degree as a consequence of Tekes support.

Company Investment Allocations and Rationale

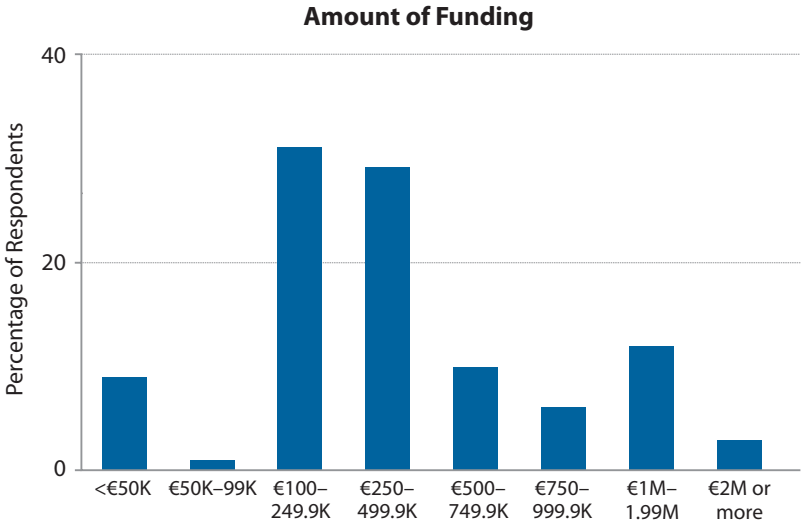
While all respondents received funding from Tekes, the amount of funding received varies greatly depending on the scope of the funded project. However, the regression analysis, found in Appendix J, indicates that the amount of funding provided by Tekes is only predictive of improvements in the ability of companies to operate efficiently. For all other capabilities measures, the amount of funding does not emerge as a significant variable explaining improvements.

Further, respondents invested in people and external services to the greatest degree, while only 26% of respondents invested the Tekes funding received in equipment or technology. However, 87% of respondents cited product or service development as part of the rationale for their investment decisions. This suggests that for the respondent companies, which are typically larger and older companies, human capital is more critical than improvements to equipment or technology for the development of innovative products or services.

In an effort to build capacity and enhance companies' capabilities, Tekes provides companies with funding.

This section provides an overview of the amount of financial support received, investment decisions, and the allocation of funding for specific business functions.

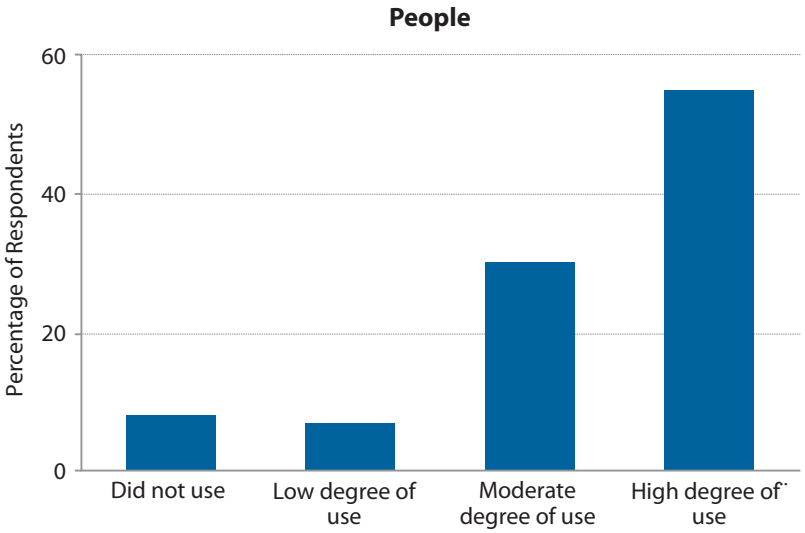
Figures describing the surveyed companies follow, each accompanied by the corresponding survey question, number of respondents (n), and analysis findings.



What is the value of funding your company has received from Tekes? n=205

Findings:

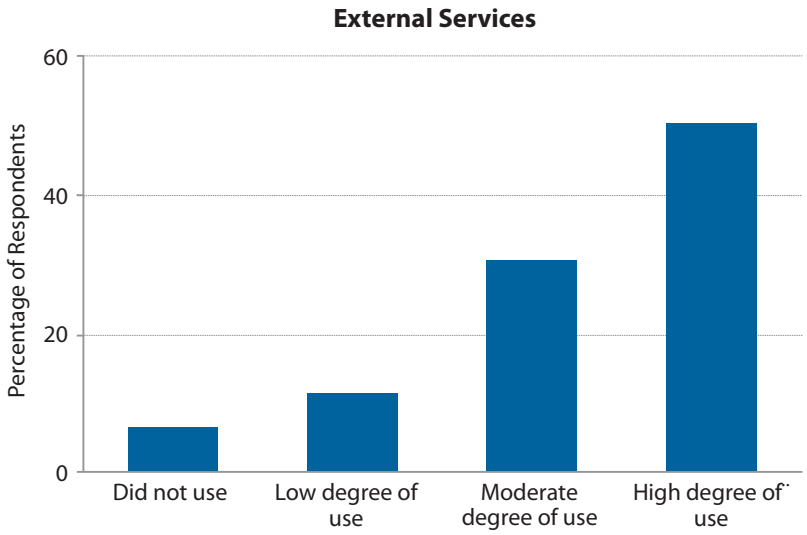
- 13% of companies received €1 million or more in funding from Tekes.
- 74% of companies received less than €500K in funding from Tekes.



Investment in people. n=195

Findings:

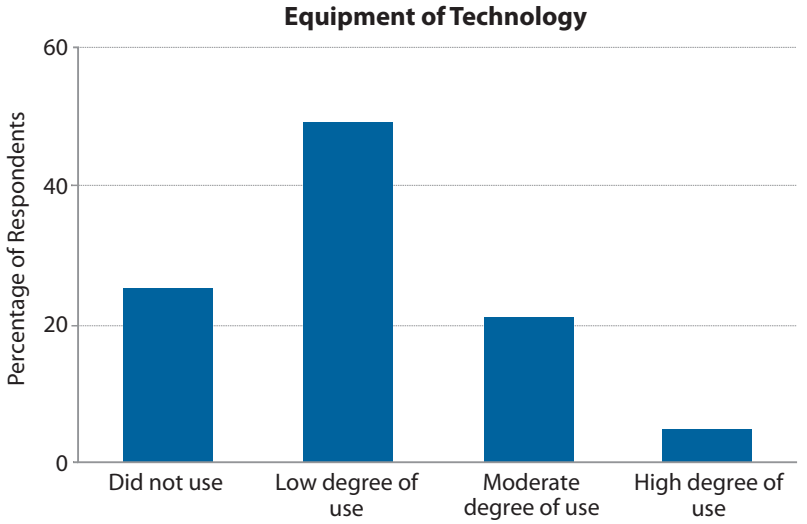
- 85% of respondents reported that their company invested in people to a 'moderate' or 'high' degree.



Investment in external services. n=196

Findings:

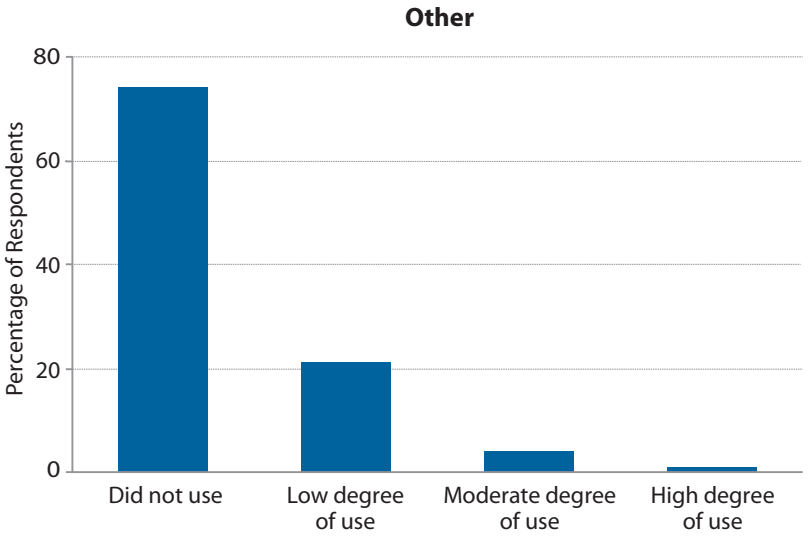
- 81% of respondents reported that their company invested in external services to a 'moderate' or 'high' degree.



Investment in equipment or technology. n=185

Findings:

- 26% of respondents reported that their company invested in equipment or technology to a 'moderate' or 'high' degree.



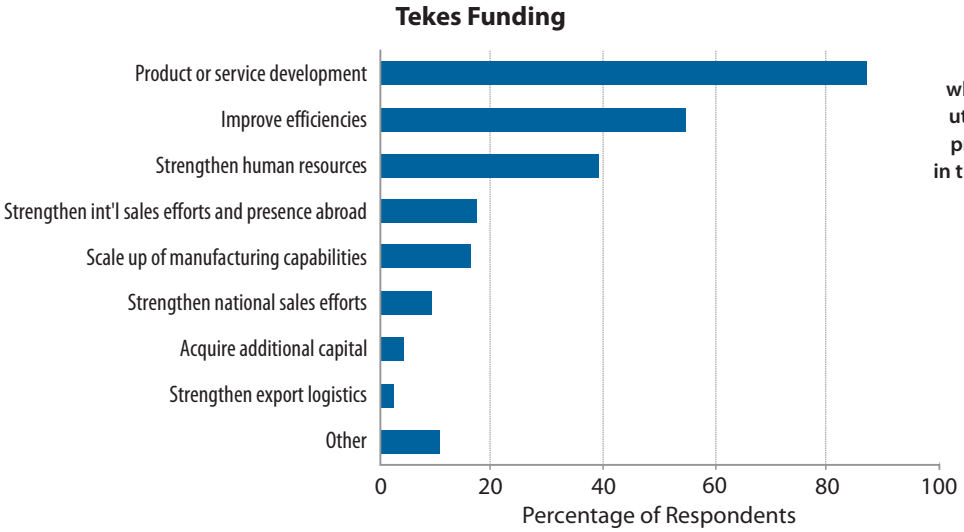
Investment in other areas[8]. n=141

Findings:

- 5% of respondents reported that their company invested in other areas of their business to a 'moderate' or 'high' degree.

Additionally, we seek to understand why the funding provided by Tekes was invested in the specific areas identified by companies shown above.

The following frequency distribution provides insight into the rationale for the internal distribution of funds received.



Please identify why your company utilized the money provided by Tekes, in the areas selected in the previous question.[9] n=196[10]

[8] Respondents that identified 'Other' areas for investment were given the opportunity to provide a literal response. These responses may be found in Appendix H.

[9] Respondents that identified 'Other' investment rationales were given the opportunity to provide a literal response. These responses may be found in Appendix H.

[10] Respondents were invited to select all that applied. As a result the percentages may not add to 100.

Findings:

- 87% of respondents cited 'product or service development' as part of the rationale for the investment decisions in people, services, or equipment and technology made by their company.
- 54% of respondents cited an interest in 'improving efficiencies' as part of the rationale for the investment decisions in people, services, or equipment and technology made by their company.
- 39% of respondents cited an interest in 'strengthening human resources' as part of the rationale for the investment decisions in people, services, or equipment and technology made by their company.

Regression Analysis of Company Capabilities

The regression analysis indicated that external mechanisms related to Tekes funding, the degree of engagement with SMEs, and the degree of engagement with research organizations are the best predictors of improvements to company capabilities.

In this section, we consider the question of what is improving companies' capabilities. To do so, we conducted statistical examinations of the relationships between the capabilities measures and predictors of the improvements on capabilities. We consider two kinds of predictors: 1) company attributes, and 2) the impact of internal mechanisms that we include as control variables and the impact of external mechanisms on overall capabilities.

The full, in-depth regression analysis, with all of the regression models, is provided in Appendix J. Here we present the most pertinent findings.

Regression Findings

The regression analysis indicates it is the external mechanisms related to Tekes funding that best predicts the improvements to companies' operational efficiency capabilities. This means that as the amount of funding increases, so do the improvements to companies' operational efficiency capabilities.

Further, companies that engage with SMEs to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to domestic market capabilities, and with impact on their improvements to knowledge management capabilities.

In addition, companies that engaged with research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to RDI collaboration capabilities.

Moreover, it was found that growing companies are more likely to attribute Tekes with impact on improvements to their operational efficiency capabilities, and as well as with impact on improvements to their domestic market capabilities.

Additionally, companies with headquarters outside of the Uusimaa region are more likely to attribute Tekes with impact on their improvements to operational efficiency.

Finally, it was determined that internal mechanisms related to new strategy objectives also predict improvements to companies' domestic market capabilities.

Recommendations Pertaining to Company Capabilities

The exploration of the *Financial resources* capability, presented previously in the source of change section, suggests that Tekes has the greatest impact on improvements to this capability, which is considered by respondent companies to be of low importance compared to other capability measures. Further, relatively few companies report that they have actually improved their *Financial resources* capability since receiving support from Tekes. However, for companies that identified the *Financial resources* capability as being of critical importance for firms in their industry, and for those that also experienced an improvement in this capability, it was found that Tekes played an instrumental role in facilitating such improvement. These findings suggest that the assistance provided by Tekes, in an effort to improve companies' *Financial resources* capabilities may only be appropriate for select companies, in particular those that indicate it is of critical importance. Therefore, to enhance its overall impact on improvements to companies' capabilities, Tekes should refocus its energies on helping companies improve capabilities that are identified by respondents as being of greater importance. There is limited value in trying to improve company capabilities that are of low importance to firms, and a reallocation of resources by Tekes to focus on companies needs may be desirable. To do so, Tekes must understand these needs, and perhaps an informational survey designed to determine the capability measures that are most important to prospective clients should be given to all companies during the application process to ensure alignment of support and services.

Further, the findings suggest that some companies experience greater improvements in specific capabilities than others. For example, because the majority of respondents represent larger, older companies, attributes typical of multinational companies operating in an international context, capabilities pertaining to domestic market intelligence are of limited use and were reported to be of lesser importance than all other capabilities. However, the regression analysis indicated that growing companies, those that are increasing revenues and employment, were more likely to attribute Tekes with impact on improvements to their ability to assess the domestic market. So although many of the larger, older companies may not benefit from assistance in this area, as they are focused on internationalization, growing companies that are expanding in both domestic and international markets will benefit and will subsequently attribute Tekes with greater impact.

Similarly, younger, growing companies were found to be more likely to attribute Tekes with impact on improvements to their customer engagement capabilities. Although a large proportion of the respondents indicated that customer engagement was important to companies in their industry, it is specifically the younger, growing companies that attribute Tekes with impact on improvements in their abilities to engage customers.

This again speaks to the requirement of Tekes to truly understand the goals and objectives of its client companies, and tailor its support and service offerings to meet their specific needs. To maximize its impact on companies, Tekes might take a more targeted support approach based on attributes and company needs.

Part II

Research Organization Capabilities

Introduction

This section of the document provides an independent, in-depth assessment of Tekes activities and support on research organizations' capabilities. The assessment was conducted by Ramboll Management Consulting (RMC) and The Evidence Network (TEN) during November 2014.

It should be noted that in this section of the report, reference is frequently made to research organizations. This terminology is used in the interests of brevity; 'research organizations' may refer to individual researchers, a university representative, or a research organization that has been engaged with Tekes and received support.

In an effort to better understand what drives improvement to research organizations' capabilities, a customized questionnaire was developed based on TEN's impact assessment methodology (see Appendix D) and key elements of the literature review presented earlier.

On 6 November 2014, an email was sent on behalf of Tekes, inviting 1163 research organizations that had engaged with Tekes to participate in a web-based survey. After four email reminders, 583 research organizations responded to the survey for a response rate of 50%. Further data on the response profile of respondent companies is provided in Appendix E.

The next section of this report provides information on the research organizations in the sample. In the seven sections that follow, we provide analyses of the importance of capabilities for organizations, the change in organizations' capabilities, the sources of change in organizations' capabilities, the impact of improvement mechanisms on organizations' capabilities, analyses of funding provided and investment rationale, analyses of the impact of funding, and high level findings from the regression analysis. In the final section we conclude with recommendations for continuous improvement.

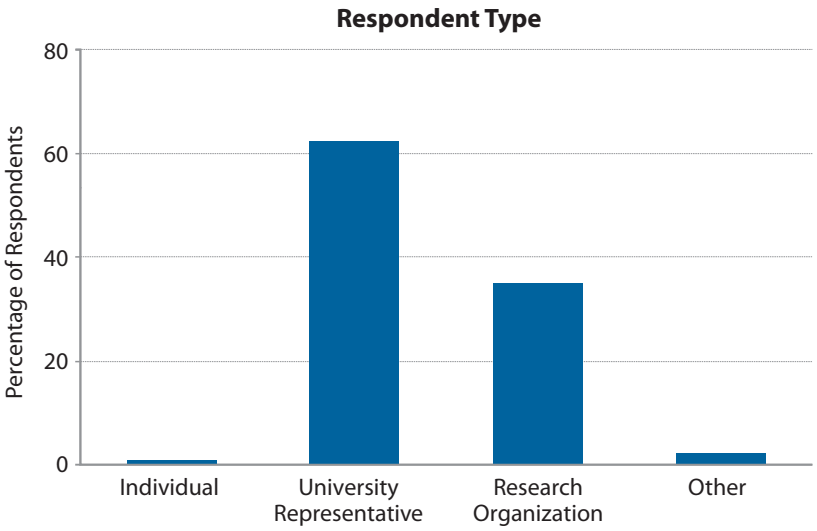
Appendices provide TEN's impact assessment methodology, details on the response profile of participant organizations, examples of questions, additional 'other' responses, regression analysis model results, and a glossary of terms.

Research Organization Information

The majority of survey respondents represent either a university or a research organization; very few individual researchers responded to the survey.

We begin by providing a breakdown of the types of survey respondents. For the purposes of Part 2 of the assessment we refer to research organizations that completed the survey as respondents.

The figure below describes the surveyed research organizations, accompanied by the corresponding survey question, number of respondents (n), and analysis findings.



Please identify the type of research organization you represent.[11] **n=532**

Findings:

- 62% of respondents identified as a university representative.
- 35% of respondents identified as a representative of a publically funded research organization.

[11] Respondents that identified as an 'Other' respondent type were given the opportunity to provide a literal response. These responses may be found in Appendix I.

Importance of Capabilities for Research Organizations

Overall, the majority of respondents indicated that the capabilities analyzed were either of critical importance or were important to their organization.

Access to research funding was identified by respondents as the most critical capability. Specifically, 80% of respondents reported that *Access to research funding* was of critical importance to their organization. Unlike the majority of the companies surveyed in Part 1 of this report, the research organizations surveyed in Part 2 do not generate substantial revenue that can be allocated towards research and development activities. As such, these organizations constantly seek other sources of financing to advance their research efforts, which leads to the elevated importance in the ability to leverage internal and external funding for the purposes of research.

Intellectual property protection was found to be the least critically important capability for research organizations.

The research organizations' capabilities were divided into three groups: 1) capabilities pertaining to **strategic direction**, 2) those pertaining to **projects and the performance of research**, and 3) capabilities that pertain to **alliances and networks**.

Among the **strategic direction** capabilities, *Access to research funding* was found to be the most critical to research organizations. Among the **alliances and networks** capabilities, *International research participation* was identified as the most critical. Finally, of the **projects and performance of research** capabilities, *Problem solving* was deemed to be the most critical. However, it should be noted that as a group of capabilities, respondents deemed the **projects and performance of research** capabilities to be the least important for their organizations.

In order to better understand the needs of the respondents, they were asked to indicate how important each capability was for their organization. As such, this section provides information on the importance of each of the 19 capabilities measures, as identified by the respondent research organizations.

The table that follows shows the 19 measures, and their associated examples, which were selected to assess research organizations' capabilities. The research organization capabilities were divided into three groups based upon the findings in the literature review: 1) **Strategic direction** (*New research models, Identify relevant research, Design research projects, International journal publications, Influence international research, Attract HQP, Access to experiment resources,* and *Access to research funding*), 2) **Alliances and networks** *(National research participation, International research participation, National research leadership, International research leadership,* and *Conduct research with companies)*, and 3) **Projects and performance of research** (*Problem solving, Advance research results, Intellectual property protection, Promote research results, Disseminate research results,* and *Commercialize research results)*

The capability measures in each of the three groupings are arranged according to the criticality of their importance in the tables that follow. We observe that in the **Strategic direction** group, *Access to research funding* was found to be the most critical to research organizations. Among the **alliances and networks** capabilities, *International research participation* was identified as the most critical. Finally, of the **projects and performance of research** capabilities, *Problem solving* was deemed to be the most critical. At a holistic level, it should be noted that when ranked according to criticality of importance, the measures that comprise the **projects and performance of research** group were typically identified to be of lesser importance than the capabilities in either of the other two groups.

Strategic Direction, Capabilities Measures.

Strategic Direction Capabilities Measures	Examples
Access to research funding	Capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.
Identify relevant research	Capabilities for the identification of scientific or technological disciplines, business sectors, or community or social imperatives that may determine the focus of individual or organizational research projects relevant to business, and more generally to society.
Design research projects	Capabilities that ensure effective linkages between strategic research directions, research plans, and resource deployment so as to optimize research productivity, such as establishment of realistic expectations in research plans, ensuring harmony between research plans and available personnel and equipment, and effective use of milestones.
International journal publications	Access to leading journals based upon peer review of the quality of research.
Attract highly qualified personnel (HQP)	Planning for and management of research, technical, and other supporting personnel to ensure that optimal competencies are available for the conduct of research, present and future, such as competency audits in relation to strategic priorities, and effective recruitment and human resource practices.
New research models	Capabilities to evaluate or develop new models for the conduct of research, for example, strategic focus on national priorities, increasing the use of multidisciplinary teams, user-pay models, or new strategies to select partners, clients, or funders.
Access to experiment resources	Capabilities include access to laboratories, specialized equipment, facilities, or data to support research investigations, creation of prototypes, new compounds, facilities for piloting and scale-up, whether directly available to researchers in organizations or secured from external sources.
Influence international research	Invitations to participate in strategic research deliberations in international forums, participation in international symposia, or provision of expert advice on research matters of international importance.

Alliances and Networks, Capabilities Measures.

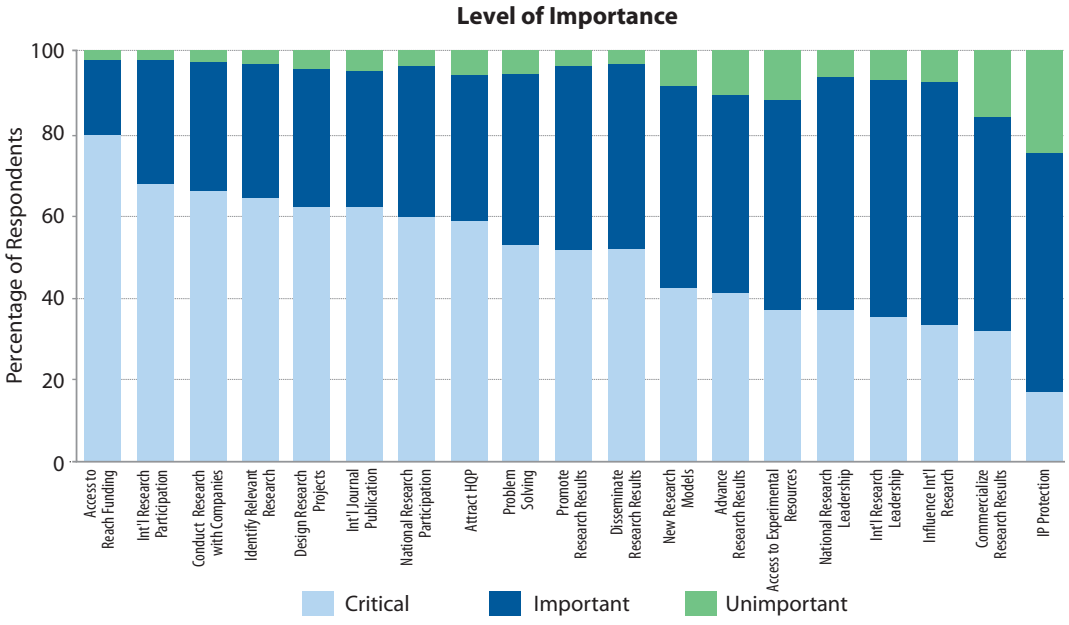
Alliances and Networks Capabilities Measure	Examples
International research participation	Capabilities to participate in international research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
Conduct research with companies	Capabilities to collaborate with companies or representatives of companies in projects, consortia, contract research, or other means by which collaborative RDI is undertaken.
National research participation	Capabilities to participate in domestic research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
National research leadership	Initiatives to create or lead new national networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.
International research leadership	Initiatives to create or lead new international networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.

Projects and Performance of Research, Capabilities Measures.

Projects and Performance of Research Capabilities Measures	Examples
Problem solving	Capabilities include those to validate ideas, assess industrial designs, process, or production issues, for example, through access to technical documents or broader literature, on-site consultations, and use of know-how.
Promote research results	Capabilities include the capacity to increase visibility or raise awareness of your RDI (research, development or innovation) capabilities, such as through presentations, reports, media outreach, networking events, etc.
Disseminate research results	Capabilities to make research more assessable to individuals, businesses, or communities, such as innovative intellectual property policies, public forums on research findings, schemes to improve spill-over access to findings by competitors, and creative involvement of public institutions to foster both procurement of research-intensive products or services, or provide greater visibility to publically funded research.
Advance research results	Capabilities include knowledge that enables creation of new research ideas, use of tools and techniques for their validation, development of prototypes, knowledge of testing protocols, ability to move from laboratory to larger scales (idea development to new or improved products or services).
Commercialize research results	Capabilities to foster the use of research such as forging research-user relationships for the identification, development, conduct, or deployment of products and services from research projects, syndicating investment in research projects by multiple end-users, or use of personnel who can articulate the benefits of complex research undertakings to less-specialized users.
Intellectual property protection	Capabilities include the identification of potentially valuable intellectual property, to ensure its protection through the use of patents, publications, documentation of know-how, or capabilities to disseminate intellectual property for use through licensing or other methods.

A frequency distribution displaying the level of importance of each capability is shown below, followed by an analysis of findings including the number of respondents (n) for each capability assessed.

To what degree is (capability) important for your organization?



Level of Importance Findings for Research Organizations

We seek to understand the distribution of scores to validate the relative importance of the 19 research organization capabilities measures. We determined the percentage of respondents who reported that a given capability was of critical importance or important to their organization. All respondents were asked to respond to questions pertaining to importance.

Access to Research Funding

n=535

- 80% (430/535) of respondents reported that access to internal and external research funding is of critical importance to their organization.
- 18% (97/535) of respondents reported that access to internal and external research funding is important to their organization.

International Research Participation

n=529

- 68% (362/529) of respondents reported that the ability to participate in international research networks is of critical importance to their organization.
- 30% (158/529) of respondents reported that the ability to participate in international research networks is important to their organization.

Conduct Research with Companies

n=530

- 67% (354/530) of respondents reported that the ability to collaborate with companies on research projects is of critical importance to their organization.
- 31% (165/530) of respondents reported that the ability to collaborate with companies on research projects is important to their organization.

Identify Relevant Research

n=547

- 65% (356/547) of respondents reported that the ability to identify relevant areas of research is of critical importance to their organization.
- 33% (178/547) of respondents reported that the ability to identify relevant areas of research is important to their organization.

Design Research Projects

n=545

- 63% (342/545) of respondents reported that the ability to design research projects is of critical importance to their organization.
- 34% (184/545) of respondents reported that the ability to design research projects is important to their organization.

International Journal Publications

n=542

- 63% (339/542) of respondents reported that the ability to publish in leading international journals is of critical importance to their organization.
- 33% (181/542) of respondents reported that the ability to publish in leading international journals is important to their organization.

National Research Participation

n=529

- 60% (317/529) of respondents reported that the ability to participate in national research networks is of critical importance to their organization.
- 37% (196/529) of respondents reported that the ability to the ability to participate in national research networks is important to their organization.

Attract Highly Qualified Personnel (HQP)

n=539

- 59% (318/539) of respondents reported that the ability to attract talented graduate students, researchers, or technical personnel is of critical importance to their organization.
- 36% (195/539) of respondents reported that the ability to attract talented graduate students, researchers, or technical personnel is important to their organization.

Problem Solve

n=537

- 53% (287/537) of respondents reported that the ability to problem solve is of critical importance to their organization.
- 42% (224/537) of respondents reported that the ability to problem solve is important to their organization.

Disseminate Research Results

n=528

- 52% (276/528) of respondents reported that the ability to effectively disseminate research results is of critical importance to their organization.
- 45% (238/528) of respondents reported that the ability to effectively disseminate research results is important to their organization.

Promote Research Results

n=533

- 52% (278/533) of respondents reported that the ability to promote or communicate research results is of critical importance to their organization.
- 45% (240/533) of respondents reported that the ability to promote or communicate research results is important to their organization.

New Research Models

n=558

- 43% (240/558) of respondents reported that the ability to evaluate or develop new research models is of critical importance to their organization.
- 49% (275/558) of respondents reported that the ability to evaluate or develop new research models is important to their organization.

Advance Research Results

n=533

- 42% (221/533) of respondents reported that the ability to prototype, pilot, or scale-up research results is of critical importance to their organization.
- 49% (259/533) of respondents reported that the ability to prototype, pilot, or scale-up research results is important to their organization.

Access to Experiment Resources

n=538

- 37% (201/538) of respondents reported that the ability to access experiment facilities, resources, or data is of critical importance to their organization.
- 51% (276/538) of respondents reported that the ability to access experiment facilities, resources, or data is important to their organization.

National Research Leadership

n=528

- 37% (197/528) of respondents reported that the ability to create or lead new national research networks is of critical importance to their organization.
- 57% (302/528) of respondents reported that the ability to create or lead new national research networks is important to their organization.

International Research Leadership

n=526

- 36% (187/526) of respondents reported that the ability to create or lead new international research networks is of critical importance to their organization.
- 58% (304/526) of respondents reported that the ability to create or lead new international research networks is important to their organization.

Influence International Research

n=538

- 34% (182/538) of respondents reported that the ability to influence international research agendas is of critical importance to their organization.
- 59% (319/538) of respondents reported that the ability to influence international research agendas is important to their organization.

Commercialize Research Results

n=527

- 32% (170/527) of respondents reported that the ability to foster the use of research for the purposes of commercializing research results is of critical importance to their organization.
- 52% (276/527) of respondents reported that the ability to foster the use of research for the purposes of commercializing research results is important to their organization.

Intellectual Property Protection

n=531

- 18% (93/531) of respondents reported that the ability to identify, protect, or license intellectual property is of critical importance to their organization.
- 58% (308/531) of respondents reported that the ability to identify, protect, or license intellectual property is important to their organization.

Change in Capabilities for Research Organizations

Overall, for the majority of capabilities measures, respondents indicated that their organization's capacity to perform either improved or stayed the same since receiving Tekes support.

The New *research models* capability was identified by organizations as the capability for which they experienced the greatest change. Specifically, 76% of respondents reported that their organization's ability to evaluate or develop new research models has improved since receiving Tekes support.

In keeping with the findings from the previous section, *Intellectual property protection* was found to be the capability for which the fewest respondents reported improvement, and for which the greatest number of respondents indicated their abilities have remained the same, since received Tekes support. This consistency is not surprising as the vast majority of respondents represent universities and research organizations, which would have experience and a wealth of knowledge pertaining to intellectual property protection prior to their engagement with Tekes.

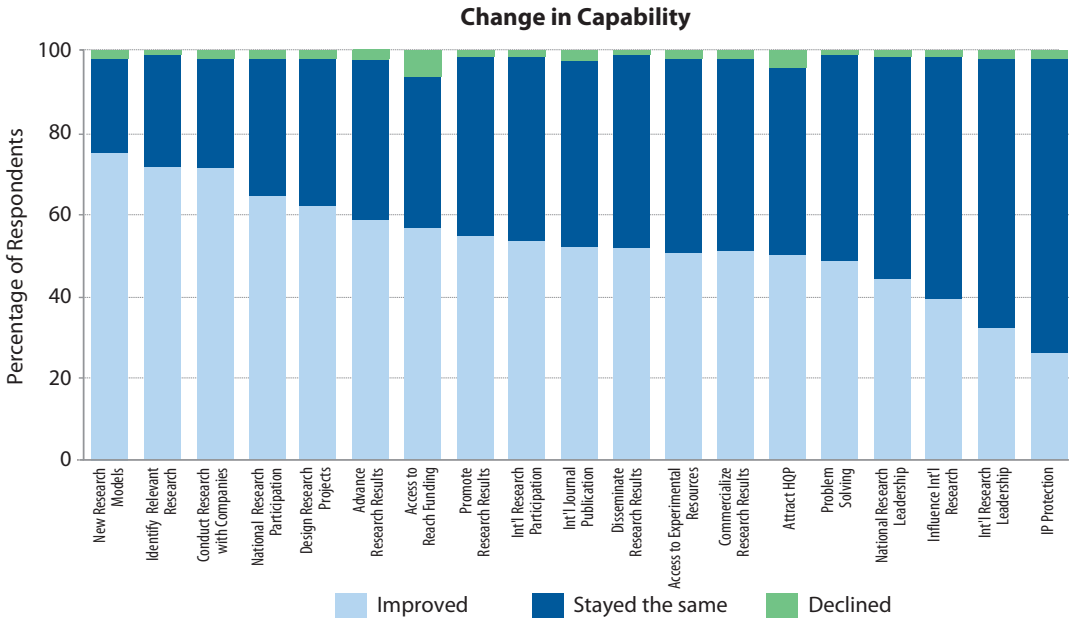
Despite *Access to research funding* as having been identified in the previous section as the most critical capability of research organizations, respondents reported that they experienced the greatest decline in this capability since receiving Tekes support. While it was not expected for all respondents to report improvements in every capability, it was also not expected that research organizations would experience the greatest decline in the capability identified as the most important.

Building on the findings from the previous section, once it was determined that a given capability was important, and therefore relevant, respondents were asked to indicate their organization's improvement in that capability since receiving Tekes support. The purpose of Tekes funding and support provided is to improve the capabilities of the organizations. As such, we seek to understand whether research organizations' capacity to perform has improved, remain unchanged, or declined with regard to specific

capabilities since receiving Tekes support. This section provides information on the change experienced by respondent organizations for each of the 19 capabilities measures, as identified by the respondent organizations.

A frequency distribution showing the changes in capabilities is shown below.

Since receiving Tekes support, how has your organization's (capability) changed?



Change in Capabilities Findings for Research Organizations

We seek to understand the distribution of scores to validate the relative improvement experienced by respondent organizations for each of the 19 company capabilities measures. We determined the percentage of respondents who reported improvements to each of the capabilities. Only respondents that answered 'critical importance' or 'important' to the question pertaining to the importance of a given capability were asked to respond to the associated question pertaining to the change in that capability.

New Research Models

n=511

- 76% (386/511) of respondents reported that their organization's ability to evaluate or develop new research models has improved since receiving Tekes support.

Identify Relevant Research

n=534

- 72% (385/534) of respondents reported that their organization's ability to identify relevant areas of research has improved since receiving Tekes support.

Conduct Research with Companies

n=518

- 72% (372/518) of respondents reported that their organization's ability to collaborate with companies on research projects has improved since receiving Tekes support.

National Research Participation

n=509

- 65% (330/509) of respondents reported that their organization's ability to participate in national research networks has improved since receiving Tekes support.

Design Research Projects

n=525

- 63% (328/525) of respondents reported that their organization's ability to design research projects has improved since receiving Tekes support.

Advance Research Results

n=479

- 59% (282/479) of respondents reported that their organization's ability to prototype, pilot, or scale-up research results has improved since receiving Tekes support.

Access to Research Funding

n=527

- 57% (301/527) of respondents reported that their organization's ability to access internal and external research funding has improved since receiving Tekes support.

Promote Research Results

n=516

- 55% (285/516) of respondents reported that their organization's ability to promote or communicate research results has improved since receiving Tekes support.

International Research Participation

n=518

- 54% (280/518) of respondents reported that their organization's ability to participate in international research networks has improved since receiving Tekes support.

International Journal Publications

n=519

- 53% (273/519) of respondents reported that their organization's ability to publish in leading international journals has improved since receiving Tekes support.

Disseminate Research Results

n=513

- 52% (268/513) of respondents reported that their organization's ability to effectively disseminate research results has improved since receiving Tekes support.

Commercialize Research Results

n=444

- 51% (228/444) of respondents reported that their organization's ability to foster the use of research for the purposes of commercializing research results has improved since receiving Tekes support.

Access to Experiment Resources

n=475

- 51% (242/475) of respondents reported that their organization's ability to access experiment facilities, resources, or data has improved since receiving Tekes support.

Attract Highly Qualified Personnel (HQP)

n=512

- 50% (258/512) of respondents reported that their organization's ability to attract talented graduate students, researchers, or technical personnel has improved since receiving Tekes support.

Problem Solve

n=511

- 49% (251/511) of respondents reported that their organization's ability to problem solve has improved since receiving Tekes support.

National Research Leadership

n=498

- 44% (221/498) of respondents reported that their organization's ability to create or lead new national research networks has improved since receiving Tekes support.

Influence International Research

n=500

- 39% (197/500) of respondents reported that their organization's ability to influence international research agendas has improved since receiving Tekes support.

International Research Leadership

n=489

- 33% (159/489) of respondents reported that their organization's ability to create or lead new international research networks has improved since receiving Tekes support.

Intellectual Property Protection

n=401

- 26% (105/401) of respondents reported that their organization's ability to identify, protect, or license intellectual property has improved since receiving Tekes support.

Source of Change in Capabilities for Research Organizations

Tekes support was consistently identified by respondents as a source of change for all capabilities; for each capability, between 63% and 80% of respondents identified that Tekes support led, in part, to their improved capacity to perform. Additionally, and perhaps more importantly, the regression analysis found in Appendix J indicates that Tekes support, both financial and non-financial, predicts improvements in all capabilities. This means the more support that organizations receive from Tekes, either financial or non-financial, the more their capabilities or capacity to perform will improve.

Eighty percent of respondents reported that the Tekes support led, in part, to their organization's improved ability to collaborate with companies on research projects. Conversely, only 63% of respondents identified Tekes support as a source of change for their organization's improved ability to problem solve.

Further, in our previous analysis we found that respondents identified *Access to research funding* as the most critically important capability for their organization. From the regression analysis we find that organizations reporting *Access to research funding* to be of greater importance, attributed greater impact to Tekes on their ability to improve this capability. As well, organizations that identified *Access to research funding* as being important were more likely to identify Tekes as the source of their improvement in this capability. This explains why, of the respondents that identified *Access to research funding* to be important and also experienced improvement in this capability, 76% reported that it was the Tekes support received which led, in part, to their organization's improved ability to access internal or external research funding.

Beyond the findings presented in the previous two sections, it is important to determine the role that Tekes support, as well as other improvement mechanisms, plays in improving organizations' capabilities. This section provides information on the sources of change for each of the 19 capabilities measures, as identified by the respondent organizations.

The following table shows the six improvement mechanisms, and their associated description, that were selected as sources of change for research organization capabilities.

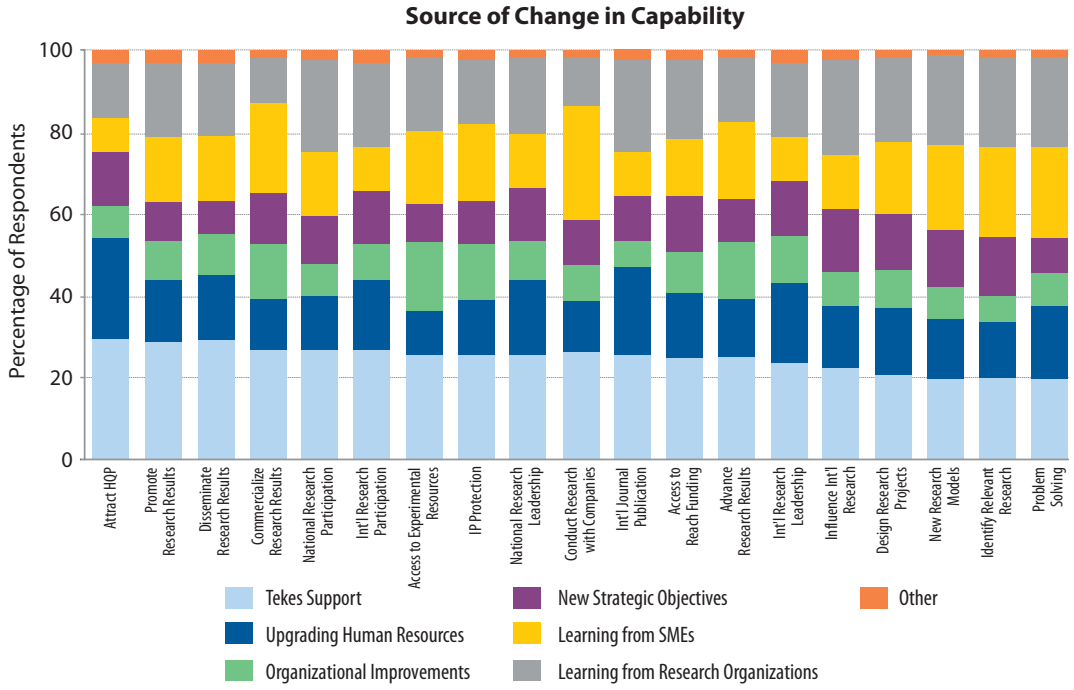
Improvement Mechanism.

Improvement Mechanism	Examples
Tekes support (financial and non-financial)	Funding and business support provided by Tekes.
Upgrading human resources	Improved in-house expertise or improved ability to leverage external expertise.
Organizational improvements	New organizational processes, equipment, or infrastructure.
New strategic objectives	Pursuit of new strategic objectives that required new capabilities.
Learning from companies	Insights and capabilities gained from engaging with companies.
Learning from other research organizations	Insights and capabilities gained from engaging with other research organizations.

A frequency distribution showing the sources of changes in capabilities is shown below.

Respondents were invited to select all sources of change that applied to their research organization; this results in a greater number of responses than respondents for each question. As such, the frequency distribution presents the source of change findings as percentage of responses. However, the descriptive findings that follow are more meaningful when presented as percentage of respondents rather than responses. So while the frequency distribution and the descriptive findings do not align, they are both the clearest possible representations of the data.

Which of the following led to improvements in your organization's (capability)? Please select all that apply.[12]



[12] Respondents that identified 'Other' sources of change were given the opportunity to provide a literal response. These responses may be found in Appendix I.

Source of Change in Capabilities Findings for Research Organizations

We seek to understand the distribution of scores to validate the relative importance of each of the six improvement mechanisms for all 19 of the organization capabilities measures. Only respondents that indicated improvement in a given capability were asked to respond to the associated question pertaining to the source of change in that capability.

Conduct Research with Companies

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=372) accounts for 33% of the total number of responses (n=1119).

- 82% (306/372) of respondents reported that learnings from companies led, in part, to their organization's improved ability to collaborate with companies on research projects.
- 80% (296/372) of respondents reported that the Tekes support led, in part, to their organization's improved ability to collaborate with companies on research projects.
- 39% (144/372) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to collaborate with companies on research projects.

Commercialize Research Results

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=228) accounts for 35% of the total number of responses (n=660).

- 79% (180/228) of respondents reported that the Tekes support led, in part, to their organization's improved ability to foster the use of research for the purposes of commercializing research results.
- 63% (144/228) of respondents reported that learnings from companies led, in part, to their organization's improved ability to foster the use of research for the purposes of commercializing research results.
- 39% (88/228) of respondents reported that new organizational processes, equipment, or infrastructure led, in part, to their organization's improved ability to foster the use of research for the purposes of commercializing research results.

National Research Participation

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=330) accounts for 34% of the total number of responses (n=967).

- 79% (260/330) of respondents reported that the Tekes support led, in part, to their organization's improved ability to participate in national research networks.
- 69% (226/330) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to participate in national research networks.
- 44% (146/330) of respondents reported that learnings from companies led, in part, to their company's improved ability to participate in national research networks.

International Research Participation

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=280) accounts for 34% of the total number of responses (n=814).

- 78% (219/280) of respondents reported that the Tekes support led, in part, to their organization's improved ability to participate in international research networks.
- 62% (173/280) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to participate in international research networks.
- 51% (144/280) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to participate in international research networks.

National Research Leadership

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=221) accounts for 34% of the total number of responses (n=655).

- 78% (172/221) of respondents reported that the Tekes support led, in part, to their organization's improved ability to create or lead new national research networks.

- 58% (128/221) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to create or lead new national research networks.
- 53% (116/221) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to create or lead new national research networks.

Disseminate Research Results

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=268) accounts for 38% of the total number of responses (n=706).

- 78% (208/268) of respondents reported that the Tekes support led, in part, to their organization's improved ability to effectively disseminate research results.
- 50% (134/268) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to effectively disseminate research results.
- 41% (111/268) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to effectively disseminate research results.

International Research Leadership

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=159) accounts for 31% of the total number of responses (n=509).

- 77% (123/159) of respondents reported that the Tekes support led, in part, to their organization's improved ability to create or lead new international research networks.
- 62% (98/159) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to create or lead new international research networks.
- 60% (95/159) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to create or lead new international research networks.
- 47% (75/159) of respondents reported that new strategic objectives led, in part, to their organization's improved ability to create or lead new international research networks.

Promote Research Results

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=284) accounts for 38% of the total number of responses (n=744).

- 76% (217/284) of respondents reported that the Tekes support led, in part, to their organization's improved ability to promote or communicate research results.
- 49% (140/284) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to promote or communicate research results.
- 40% (113/284) of respondents reported that learnings from companies led, in part, to their organization's improved ability to promote or communicate research results.

Advance Research Results

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=281) accounts for 33% of the total number of responses (n=851).

- 76% (214/281) of respondents reported that the Tekes support led, in part, to their organization's improved ability to prototype, pilot, or scale-up research results.
- 55% (154/281) of respondents reported that learnings from companies led, in part, to their organization's improved ability to prototype, pilot, or scale-up research results.
- 50% (140/281) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to prototype, pilot, or scale-up research results.
- 44% (123/281) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to prototype, pilot, or scale-up research results.

Access to Research Funding

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=301) accounts for 33% of the total number of responses (n=909).

- 76% (228/301) of respondents reported that the Tekes support led, in part, to their organization's improved ability to access internal and external research funding.

- 61% (183/301) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to access internal and external research funding.
- 48% (144/301) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to access internal and external research funding.
- 44% (133/301) of respondents reported that new strategic objectives led, in part, to their organization's improved ability to access internal and external research funding.

Attract Highly Qualified Personnel (HQP)

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=258) accounts for 40% of the total number of responses (n=652).

- 75% (193/258) of respondents reported that the Tekes support led, in part, to their organization's improved ability to attract talented graduate students, researchers, or technical personnel.
- 64% (165/258) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to attract talented graduate students, researchers, or technical personnel.
- 37% (95/258) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to attract talented graduate students, researchers, or technical personnel.

Access to Experiment Resources

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=242) accounts for 37% of the total number of responses (n=664).

- 71% (172/242) of respondents reported that the Tekes support led, in part, to their organization's improved ability to access experiment facilities, resources, or data.
- 52% (125/242) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to access experiment facilities, resources, or data.
- 48% (117/242) of respondents reported that learnings from companies led, in part, to their organization's improved ability to access experiment facilities, resources, or data.

New Research Models

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=386) accounts for 28% of the total number of responses (n=1365).

- 80% (307/386) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to evaluate or develop new research models.
- 71% (272/386) of respondents reported that the Tekes support led, in part, to their organization's improved ability to evaluate or develop new research models.
- 71% (272/386) of respondents reported that learnings from companies led, in part, to their organization's improved ability to evaluate or develop new research models.
- 52% (201/386) of respondents reported that new strategic objectives led, in part, to their organization's improved ability to evaluate or develop new research models.

International Journal Publications

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=273) accounts for 36% of the total number of responses (n=753).

- 70% (192/273) of respondents reported that the Tekes support led, in part, to their organization's improved ability to publish in leading international journals.
- 64% (174/273) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to publish in leading international journals.
- 60% (165/273) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to publish in leading international journals.

Influence International Research

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=196) accounts for 33% of the total number of responses (n=590).

- 73% (142/196) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to influence international research agendas
- 69% (135/196) of respondents reported that the Tekes support led, in part, to their organization's improved ability to influence international research agendas.
- 50% (97/196) of respondents reported that new strategic objectives led, in part, to their organization's improved ability to influence international research agendas.

Intellectual Property Protection

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=105) accounts for 37% of the total number of responses (n=281).

- 69% (72/105) of respondents reported that the Tekes support led, in part, to their organization's improved ability to identify, protect, or license intellectual property.
- 49% (51/105) of respondents reported that learnings from companies led, in part, to their organization's improved ability to identify, protect, or license intellectual property.
- 45% (47/105) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to identify, protect, or license intellectual property.

Design Research Projects

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=328) accounts for 31% of the total number of responses (n=1060).

- 68% (223/328) of respondents reported that the Tekes support led, in part, to their organization's improved ability to design research projects.
- 68% (223/328) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to design research projects.
- 57% (186/328) of respondents reported that learnings from companies led, in part, to their organization's improved ability to design research projects.
- 52% (171/328) of respondents reported that upgrades to human resources led, in part, to their organization's improved ability to design research projects.

Identify Relevant Research

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=384) accounts for 30% of the total number of responses (n=1296).

- 76% (292/384) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to identify relevant areas of research.
- 73% (280/384) of respondents reported that learnings from companies led, in part, to their organization's improved ability to identify relevant areas of research.
- 68% (260/384) of respondents reported that the Tekes support led, in part, to their organization's improved ability to identify relevant areas of research.

Problem Solve

Respondents were encouraged to select all sources of change that applied. As such, the number of respondents (n=251) accounts for 32% of the total number of responses (n=784).

- 70% (176/251) of respondents reported that learnings from other research organizations led, in part, to their organization's improved ability to problem solve.
- 69% (172/251) of respondents reported that learnings from companies led, in part, to their organization's improved ability to problem solve.
- 63% (157/251) of respondents reported that the Tekes support led, in part, to their organization's improved ability to problem solve.

Impact of Improvement Mechanisms on Capabilities for Research Organizations

Ninety-nine percent of respondents reported that the financial support received from Tekes had a positive impact on improving their capabilities, their overall capacity to perform. The findings indicate that the impact attributed to the *Tekes financial support* mechanism was higher than the impacts attributed to all other improvement mechanisms.

Additionally, the Tekes non-financial support was deemed by respondents to have the least impact on improving their overall capacity to perform.

In the previous section respondents were asked which mechanisms led to improvements in each specific capabilities measure. However, it is also important to understand the role of the various mechanisms in facilitating improvements in organizational capabilities as a whole, rather than on a measure-by-measure basis. As such, this section provides an overview of the impact of the seven mechanisms on the overall improvement to organizations' capabilities.[13]

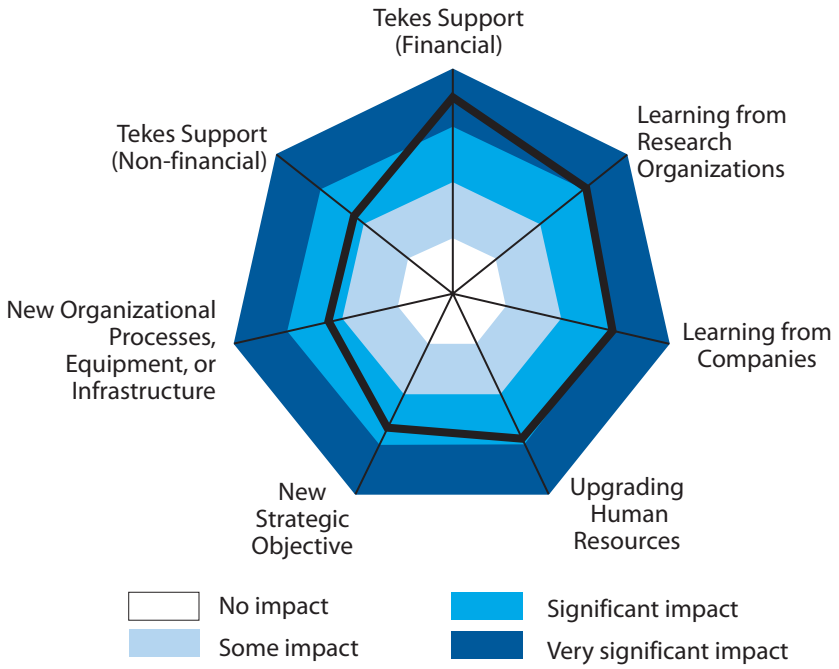
Respondents were asked to indicate the impact of each of the seven improvement mechanisms on their organization's overall capabilities.[14] The following lead question was presented to respondents:

To what degree have each of the following mechanisms impacted your research or your organization's overall capabilities?

Details on our standardized question format are provided in Appendix G.

Reading clockwise in the following figure, the average impacts of the improvement mechanisms range from the middle of 'very significant impact' for the *Tekes financial support* mechanism to the low-end of the 'significant impact' range for the *Tekes non-financial support* mechanism.

Average Impact of the Improvement Mechanisms on Organizations' Overall Capabilities

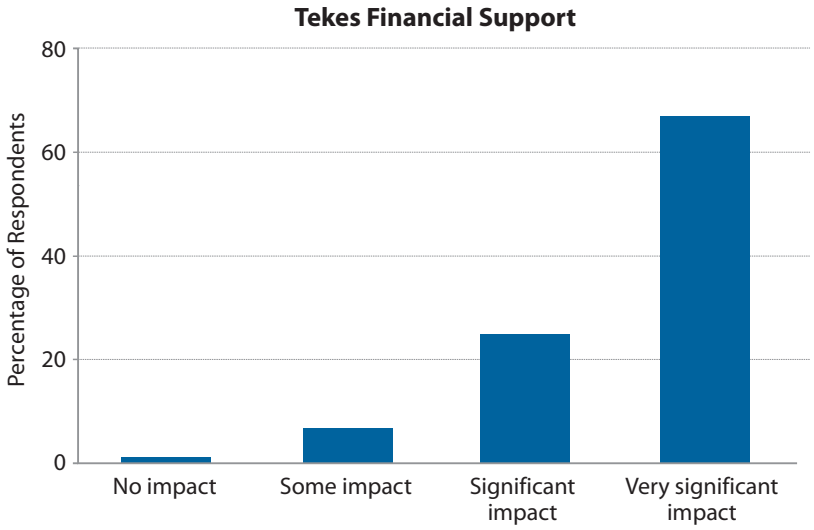


[13] Impact is measured on a scale using the following weights: 'No impact' 2.5, 'Some impact' 5.0, 'Significant impact' 7.5, 'Very significant impact' 10.0.

[14] To determine the impact of the mechanisms on improving organization's overall capabilities, Tekes support was split into financial and non-financial support, with respondents having the choice to select one or the other, as well as both.

We tested for significant differences among the improvement mechanisms and found that the impact attributed to the *Tekes financial support* mechanism was higher than the impacts attributed to all other improvement mechanisms (significant at the 99% confidence level).

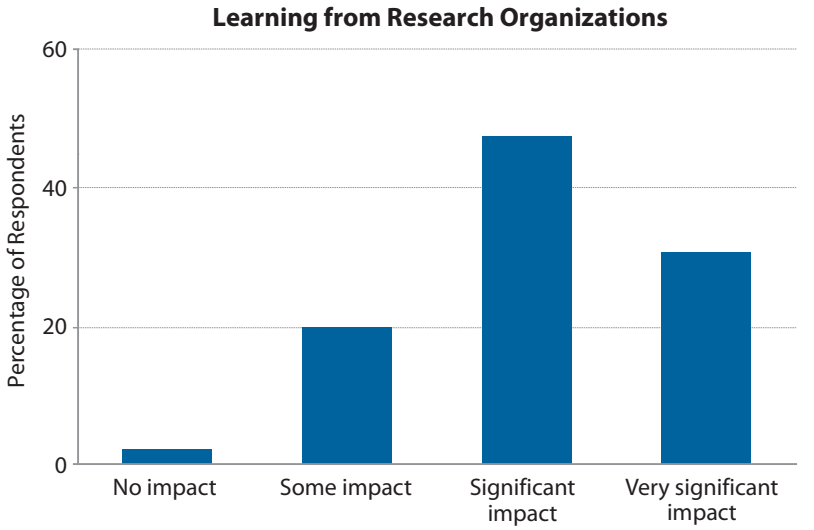
The frequency distributions that follow show impact responses for all seven improvement mechanisms, together with the corresponding survey questions, number of respondents, average impact scores (out of 10), and analysis findings.



To what degree has the financial Tekes support received impacted your organization's overall capabilities?
n=530
Average=8.9

Finding:

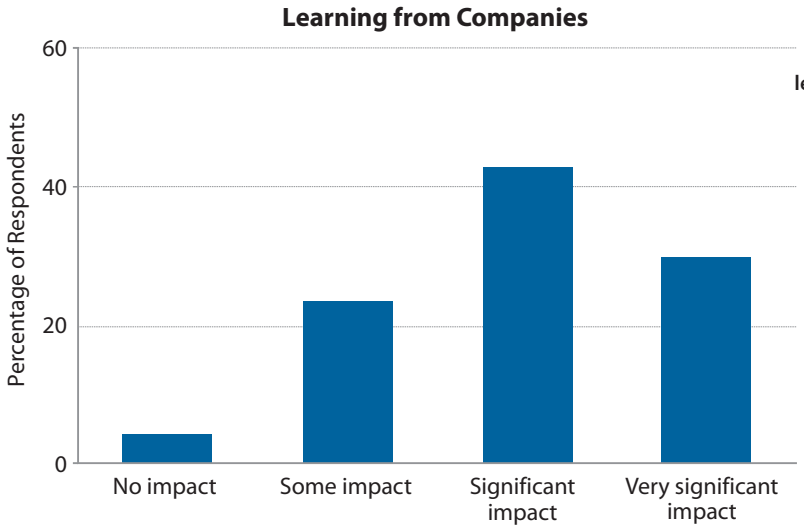
- 99% (522/530) of respondents reported that the Tekes financial support received had a positive impact on improvements to their organization's overall capabilities.



To what degree have learnings from other research organizations impacted your organization's overall capabilities?
n=526
Average=7.7

Finding:

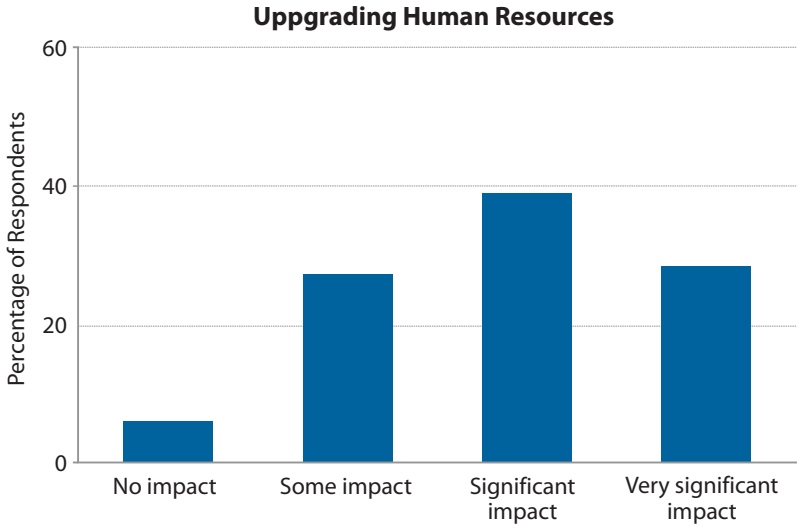
- 98% (515/526) of respondents reported that learnings from other research organizations had a positive impact on improvements to their organization's overall capabilities.



To what degree have learnings from companies impacted your organization's overall capabilities?
n=524
Average=7.4

Finding:

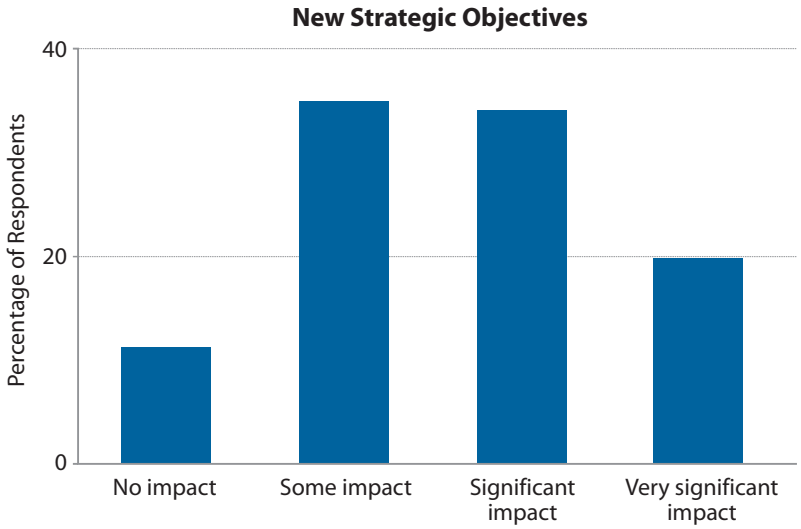
- 96% (502/524) of respondents reported that learnings from companies had a positive impact on improvements to their organization's overall capabilities.



To what degree has upgrading human resources impacted your organization's overall capabilities?
n=528
Average=7.2

Finding:

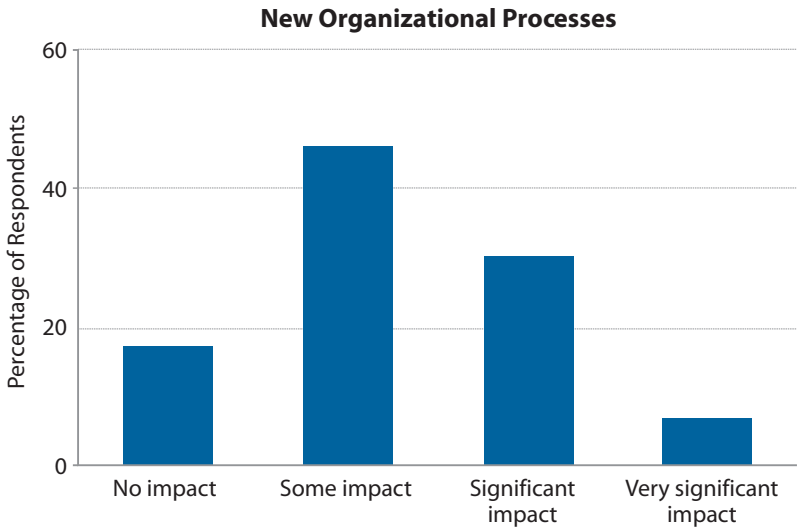
- 94% (497/528) of respondents reported that upgrades to human resources had a positive impact on improvements to their organization's overall capabilities.



To what degree have new strategic objectives impacted your organization's overall capabilities?
n=525
Average=6.6

Finding:

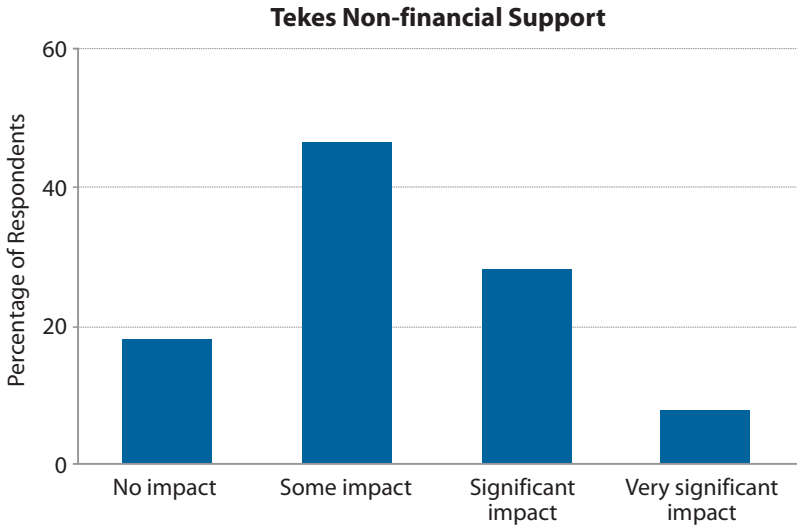
- 89% (466/525) of respondents reported that new strategic objectives had a positive impact on improvements to their organization's overall capabilities.



To what degree have new organizational processes, equipment, or infrastructure impacted your organization's overall capabilities?
n=522
Average=5.7

Finding:

- 83% (433/522) of respondents reported that new organizational processes, equipment, or infrastructure had a positive impact on improvements to their organization's overall capabilities.



To what degree has the non-financial Tekes support received impacted your organization's overall capabilities?
n=516
Average=5.6

Finding:

- 82% (423/516) of respondents reported that the Tekes non-financial support received had a positive impact on improvements to their organization's overall capabilities.

Funding for Research Organizations

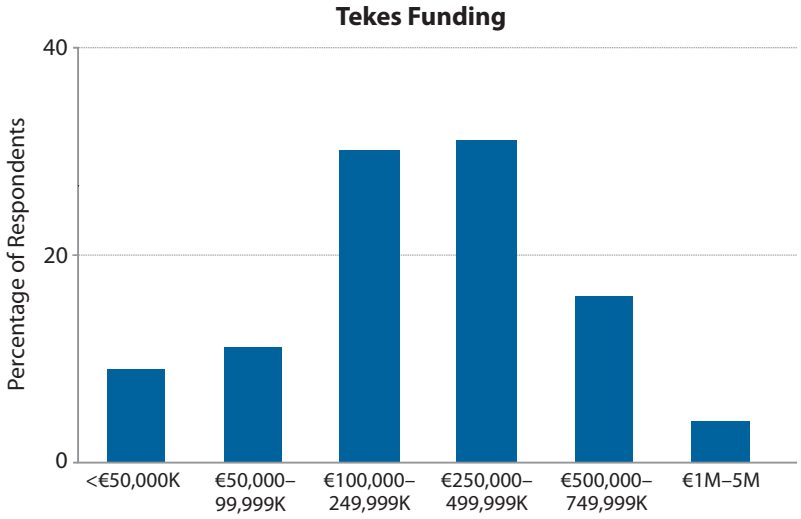
While all respondents received funding from Tekes, the amount of funding received varied greatly depending on the scope of the funded project. The regression analysis, found in Appendix J, indicates that the amount of funding provided by Tekes is predictive of improvements in only certain capabilities: *Identify relevant research, International journal publications, Commercialize research, International research participation, and International research leadership* capabilities. As such, the more funding that organizations receive from Tekes the greater their improvement in these capabilities.

In keeping with Tekes' emphasis on international researcher mobility and the creation of international collaborations, the greatest number of respondents indicated that the Tekes funding was allocated to cover travel expenses, followed closely by the number of respondents that indicated the Tekes funding was, in part, used to create networks.

In an effort to build capacity and enhance research organizations' capabilities, Tekes provides research organizations with funding.

This section provides an overview of the amount of financial support provided by Tekes, and the investment rationale of the research organizations.

Figures describing the surveyed research organizations follow, each accompanied by the corresponding survey question, number of respondents (n), and analysis findings.



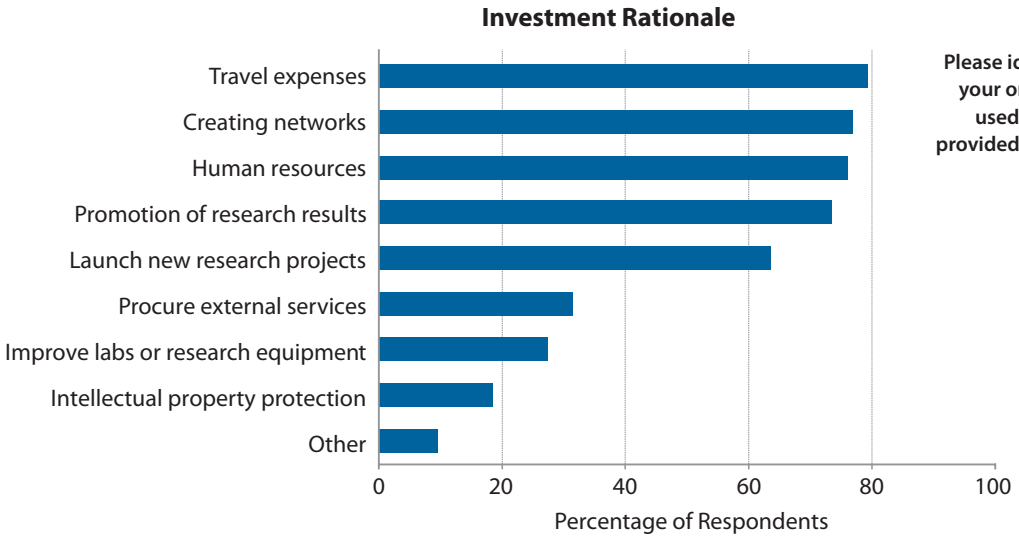
What is the value of funding your organization has received from Tekes? n=583

Finding:

- 31% of organizations received between €250K and €499K in funding from Tekes.

Additionally, we seek to understand how the funds provided by Tekes were invested by research organizations in various areas.

The following frequency distribution provides insight into the rationale for the internal distribution of funds received.



Please identify how your organization used the money provided by Tekes.[15] **n=564**[16]

Findings:

- 79% of respondents indicated that the funds provided by Tekes were, in part, directed towards 'travel expenses'.
- 77% of respondents indicated that the funds provided by Tekes were, in part, directed towards 'creating networks'.

15 Respondents that identified 'Other' rationales for investment were given the opportunity to provide a literal response. These responses may be found in Appendix I.

16 Respondents were invited to select all that applied. As a result the percentages do not add to 100.

- 76% of respondents indicated that the funds provided by Tekes were, in part, directed towards 'human resources'.
- 73% of respondents indicated that the funds provided by Tekes were, in part, directed towards the 'promotion of research results'.

Impact of Funding on Capabilities for Research Organizations

The main purpose of the Tekes support provided to research organizations, both financial and non-financial, is to facilitate research and improve organizational capabilities. All of the capabilities examined in previous sections enable improvements to RDI activities conducted by the research organizations.

In this section of the analysis, we find that the capability improvements, made possible by Tekes funding, had significant positive impacts on organizations' overall research performance.

Specifically, 97% of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on their organization's ability to engage in relevant research.

In this section we seek to understand the areas of research that are most impacted by improvements to organizations' capabilities. Respondents were asked to indicate the impact of improvements to organizations' capabilities on various research performance measures.[17]

The following lead question was presented to respondents:

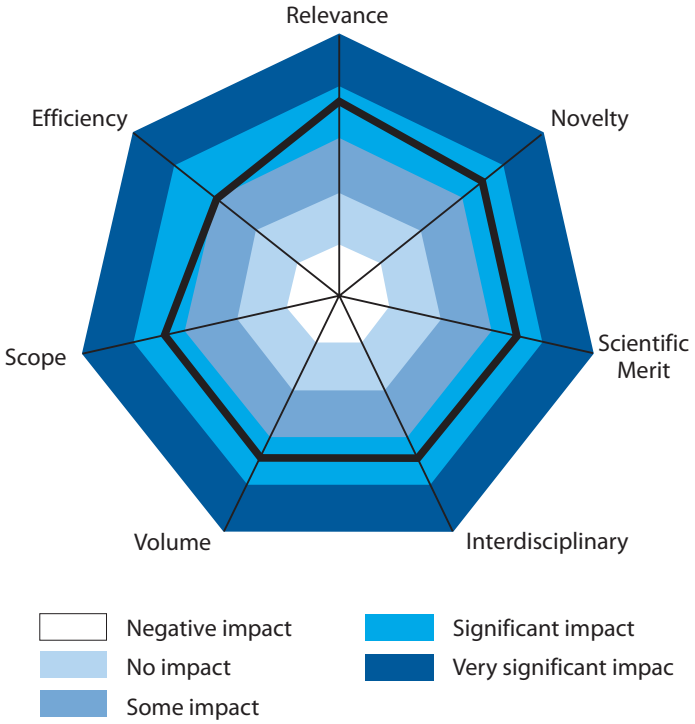
Since receiving Tekes support, to what degree have the improvements to your organizations' capabilities, made possible by Tekes funding, improved your organization's research performance according to each of the following measures?

Details on our standardized question format are provided in Appendix G.

Reading clockwise in the following figure, the average impacts of the improvements to organizations' capabilities range from the high-end of 'significant impact' on organizations' ability to engage in relevant research to the low-end of the 'significant impact' range on organizations' ability to improve research efficiency.

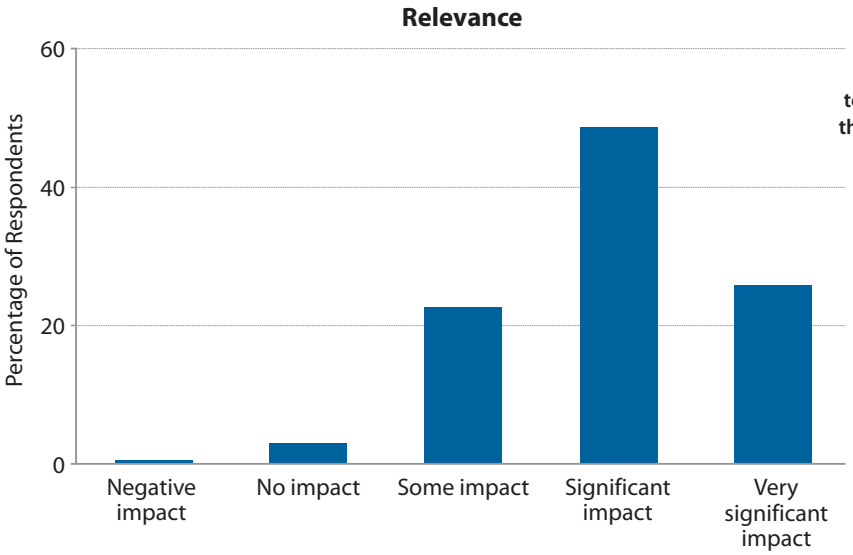
[17] Impact is measured on a scale using the following weights: 'Negative' 0, 'No impact' 2.5, 'Some impact' 5.0, 'Significant impact' 7.5, 'Very significant impact' 10.0.

Average Impact of the Improvements to Organizations' Capabilities on Organizations' Research Performance



We tested for significant differences among the average impacts of the improvements to organizations' capabilities on the research performance measures and found that the impact on the ability of organizations to engage in relevant research was higher than the impacts on all other research performance measures (significant at the 99% confidence level).

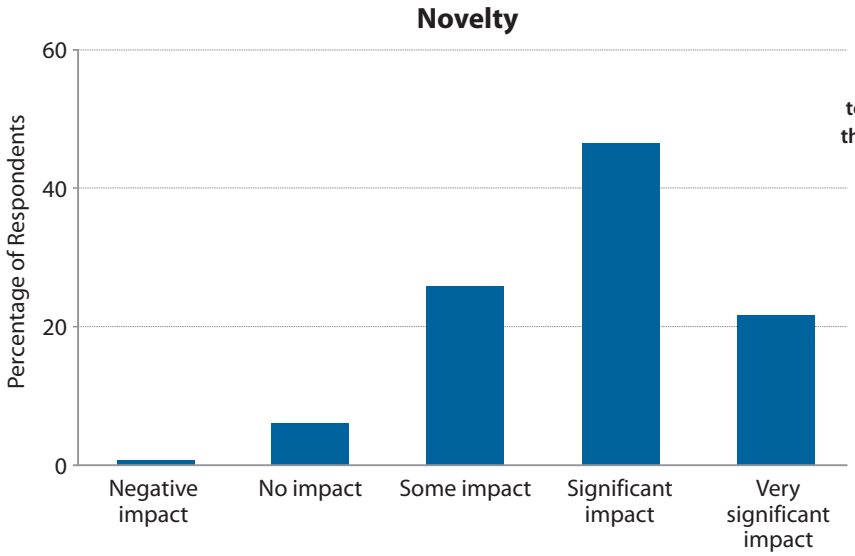
The frequency distributions that follow show impact responses for the seven research performance measures, together with the corresponding survey questions, number of respondents, average impact scores (out of 10), and analysis findings.



Since receiving Tekes support, to what degree have the improvements to your organizations' capabilities, made possible by Tekes funding, improved your organization's research performance according to relevance?
n=521
Average=7.4

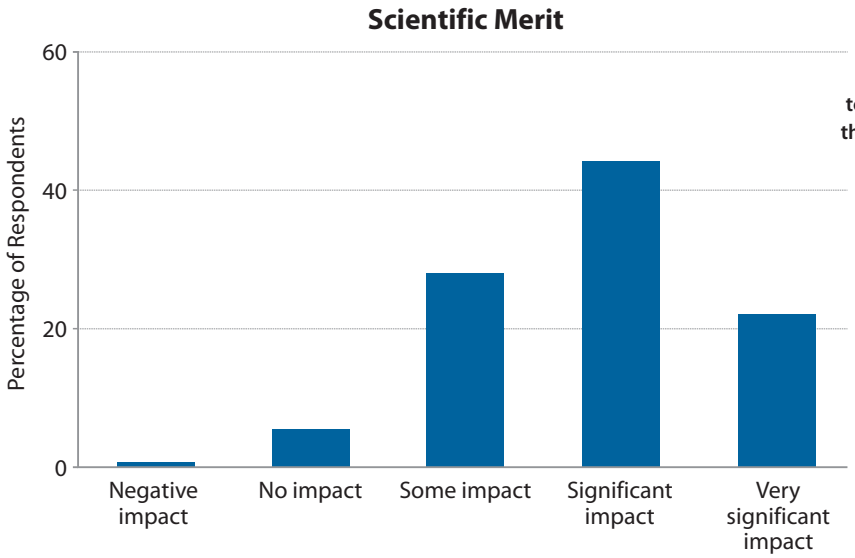
Finding:

- 97% (505/521) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to engage in relevant research.



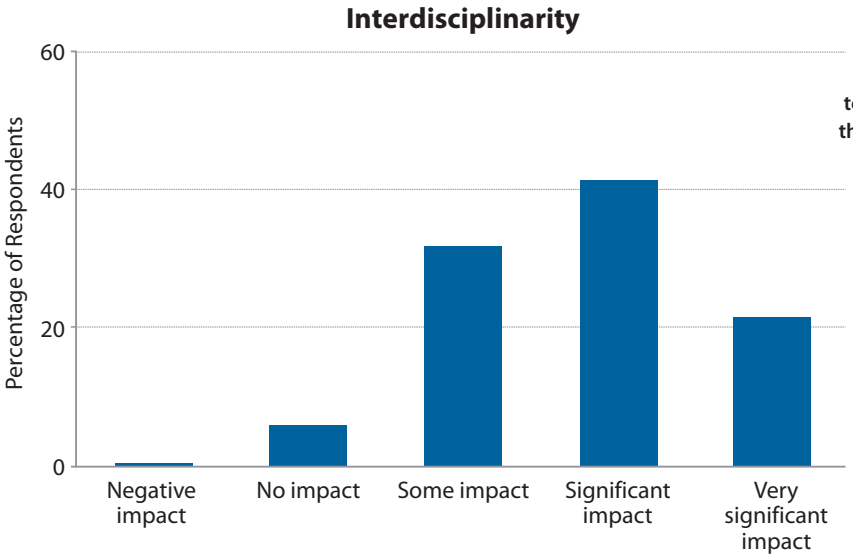
Finding:

- 94% (488/522) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to engage in novel research.



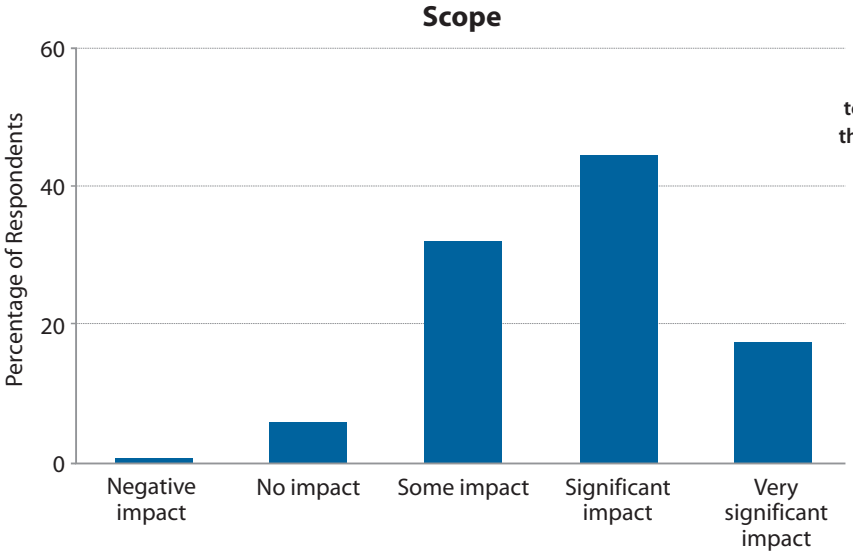
Finding:

- 94% (493/524) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to engage in research of greater scientific merit.



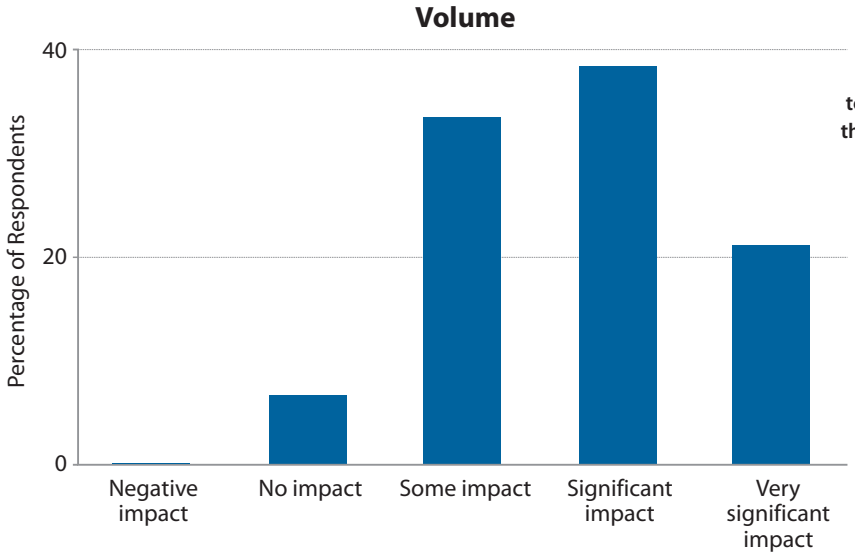
Finding:

- 94% (491/522) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to engage in interdisciplinary research.



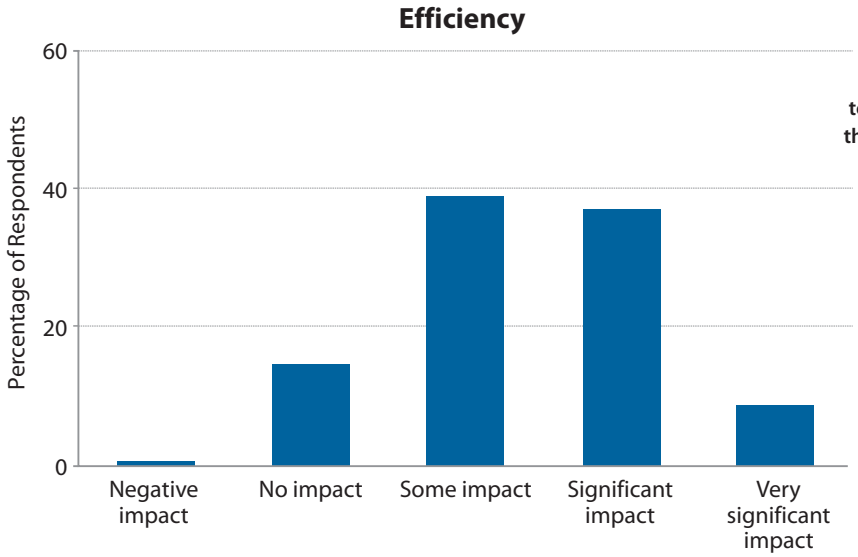
Finding:

- 94% (487/520) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to determine the appropriate scope for research.



Finding:

- 93% (485/521) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to determine the appropriate volume of research.



Finding:

- 85% (415/521) of respondents reported that the improvements to their organization's capabilities, made possible by Tekes funding, had a positive impact on improvements to their organization's ability to improve research efficiency.

Engagement of Research Organizations

In keeping with Tekes' emphasis on collaboration, engagement with small and medium enterprises (SMEs), large companies, and other research organizations is key for receiving Tekes funding and support. For most capabilities, engagement emerges as a predictor of capability improvement, as shown in the regression analysis in Appendix J. Thus, the greater the degree of organizations' engagement with companies or research organizations, the greater the improvement is to their capabilities.

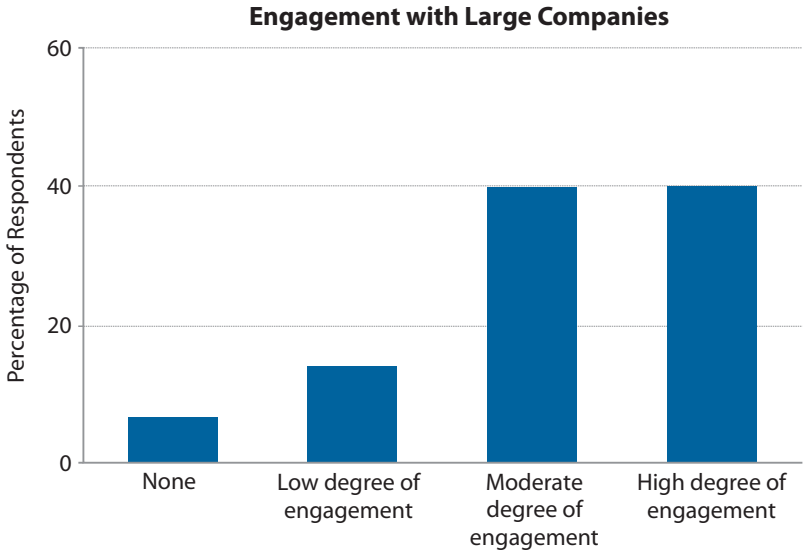
These findings suggest that the requirement for a collaborative approach to projects is positively influencing the capabilities of research organizations, and further bolsters the need for continued engagement with companies and other research organizations.

Respondents were asked to indicate their degree of engagement with other research organizations, as well as large companies and small and medium enterprises (SMEs).

Since your first engagement with Tekes, to what degree has your organization engaged with research organizations as a consequence of Tekes support? n=569

Finding:

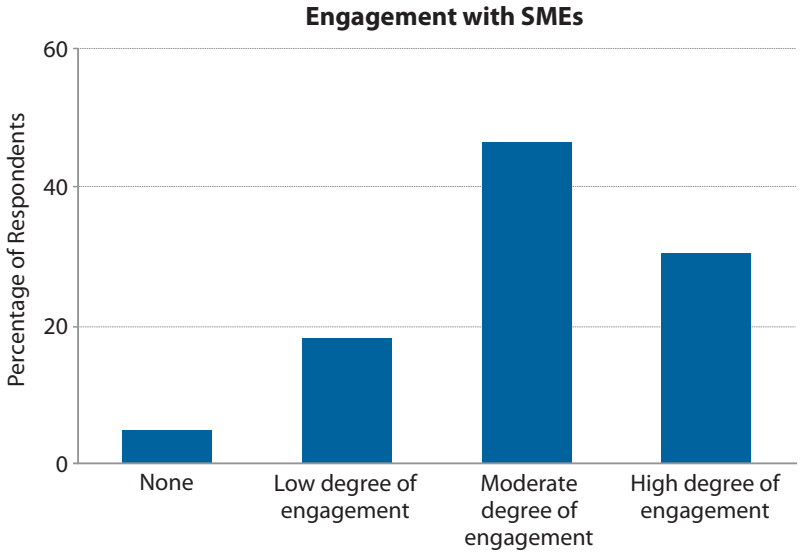
- 89% (504/569) of organizations reported that they engaged with research organizations to a 'moderate' or 'high' degree as a consequence of Tekes support.



Since your first engagement with Tekes, to what degree has your organization engaged with large companies as a consequence of Tekes support? n=566

Finding:

- 80% (450/566) of organizations reported that they engaged with large companies to a 'moderate' or 'high' degree as a consequence of Tekes support.



Since your first engagement with Tekes, to what degree has your organization engaged with SMEs as a consequence of Tekes support? n=579

Finding:

- 77% (445/579) of organizations reported that they engaged with SMEs to a 'moderate' or 'high' degree as a consequence of Tekes support.

Regression Analysis of Research Organization Capabilities

Findings from the regression analysis show that it is external mechanisms related to Tekes funding, Tekes financial support, Tekes non-financial support, degree of engagement with SMEs, and degree of engagement with other researchers or research organizations that are the best predictors of improvements to research organizations' capabilities.

In this section, we consider the question of what is improving organizations' capabilities. To do so, we conducted statistical examinations of the relationships between the capabilities measures and predictors of the improvements on capabilities. We consider two kinds of predictors: 1) organizational attributes, and 2) the impact of internal mechanisms that we include as control variables and the impact of external mechanisms on overall capabilities.

The full, in-depth regression analysis, with all of the regression models, is provided in Appendix J. Here we present the most pertinent findings.

Regression Findings

The regression analyses indicate that it is the external mechanisms related to Tekes funding that best predicts the improvements in research organizations' abilities to identify and implement relevant research. This means that as the amount of funding increases, so do the improvements to research organizations' abilities to identify and implement relevant research.

Further, the external mechanisms related to Tekes financial support is associated with the improvements in research organizations' abilities to problem solve, and in their improved ability to identify and implement relevant research.

In addition, the external mechanisms related to Tekes non-financial support is associated with the improvements in research organizations' abilities to problem solve, to influence international research agendas, to identify and implement relevant research, and to attract highly qualified personnel.

Additionally, respondents that engaged with other researchers or research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their research organizations' improved ability to influence international research agendas, and ability to identify and implement relevant research.

Finally, it was determined that internal mechanisms related to upgrading human resources also predict the improvements in research organizations' abilities to problem solve, to identify and implement relevant research, and to attract highly qualified personnel.

Recommendations Pertaining to Research Organization Capabilities

In an effort to interpret the research organization capabilities at a higher level, the capabilities were divided into three groups based on the literature review findings: 1) capabilities pertaining to **Strategic direction**, 2) those pertaining to **Projects and the performance of research**, and 3) the capabilities that pertain to **Alliances and networks**. We find that when considered as a group of capabilities, respondents deem the **Projects and performance of research** capabilities, comprised of the *Problem solving, Advance research results, Intellectual property protection, Promote research results, Disseminate research results,* and *Commercialize research results* capability measures, to be the least important for their organizations.

However, Tekes support is identified as one of the main sources of improvement for three of these capabilities. This means that Tekes support is playing a substantive role in improving research organizations capabilities that are deemed less important overall. Therefore, to enhance its overall impact on improvements to research organizations' capabilities, Tekes might refocus its energies on helping organizations improve capabilities that are identified by respondents as more important. Similar to the recommendation for companies in Part 1 of this report, there is limited value in trying to improve capabilities that are of low importance to organizations, and a reallocation of resources by Tekes to focus on research organizations needs is required. Tekes could maximize its impact on research organizations by directing

activities and support towards improving the Strategic direction and Alliances and networks capabilities, which are deemed to be more important by research organizations.

The report findings show that *Access to research funding* is the most important capability for research organizations, and organizations that reported this capability to be of greater importance also attributed greater impact to Tekes. Additionally, the majority of respondents indicated that their research organization had improved their abilities to leverage internal and external research funding since receiving Tekes support, and attributed Tekes with contributing to this improvement. However, of all of the capability measures analyzed, research organizations also reported the greatest decline in the *Access to research funding* capability. These findings suggest that Tekes should review its activities and support services designed to improve *Access to research funding* capabilities to ensure that the support available appropriately meets the needs of research organizations. Improving the ability of research organizations to leverage internal and external research funding represents an excellent opportunity for Tekes to increase its attributed impact on these organizations.

It was determined that the financial support provided by Tekes ranks highest among all improvement mechanisms, while the non-financial support ranks the lowest. This means that the non-financial support provided by Tekes has the lowest overall average impact on improving research organizations capabilities, compared to all other improvement mechanisms. As a result, TEN recommends that Tekes undertake a thorough review of its non-financial support initiatives and programs to ensure that they are having the desired impact on the capabilities of research organizations. This again speaks to the requirement of Tekes to truly understand the goals and objectives of research organizations it works with, and tailor its support and service offerings to meet their specific needs. To maximize its impact on research organizations, Tekes might take a more targeted support approach based on objectives and organizational needs.

Finally, TEN recommends that Tekes continue to encourage research organizations to develop their own networks through engagement with companies, both large and small, as well as with other research organizations. For the majority of the capability measures, the regression analysis showed research organization engagement with companies or other research organizations, enabled through Tekes support, to be a significant predictor of capability improvements. This suggests that there is a multiplier effect, wherein the benefits from the Tekes support can be increased when research organizations leverage this support to engage with other parties and expand their network.

Appendix A. RMC/TEN List of Capabilities

1. Engagement with potential customers and end users to gain an understanding of unmet market and societal needs
2. Market intelligence, and management of distribution channels
3. Promotion of corporate products, processes, or services
4. Evaluation and adoption of new knowledge, information, technology, products, processes, or services
5. The management of supplier networks
6. Increasing operational efficiencies
7. Design, testing, piloting of new products, processes, or services
8. Use of new innovations
9. Protection of intellectual property (for example, embodied in technology, patents, trademarks, components, platforms, or systems)
10. Addressing new product or service markets domestically
11. Addressing new product or service markets internationally
12. Evaluating and adopting new business models
13. Abandoning low performing, products, processes, services, units, or markets
14. Scanning and networking to stay abreast of technological or other change in the business environment
15. Scanning and networking to stay abreast of changes to industrial standards, regulations, or other conformance requirements
16. Research, development, or innovation (RDI) engagement with other actors (e.g. collaboration or contract RDI with other companies research institutes or universities)
17. Acquiring resources to support development of new products or services, or to support expansion
18. Working with third-parties to enhance products, processes, services, or overall organizational performance

Appendix B. Tekes List of Capabilities

1. Creating value for business and customers
2. Achieving/creating business growth
3. Strategic business management
4. Internationalization
5. Managing the innovation process
6. Adopting information and knowledge/knowhow
7. Sharing of information and knowledge
8. Combining technical and non-technical expertise
9. Interdisciplinary combination of expertise
10. Anticipating markets
11. Anticipating technology development
12. Promoting innovations
13. Utilizing R&D Networks
14. Understanding client needs
15. Managing subcontractor networks
16. Managing delivery networks
17. Operating in international markets

Appendix C. Mapping between RMC/TEN and Tekes Capabilities

RMC/TEN	Tekes
1. Engagement with potential customers and end users to gain an understanding of unmet market and societal needs	14. Understanding client needs
2. Market intelligence, and management of distribution channels	16. Managing delivery networks
3. Promotion of corporate products, processes, or services	12. Promoting innovations
4. Evaluation and adoption of new knowledge, information, technology, products, processes, or services	6. Adopting information and knowledge/knowhow 5. Managing the innovation process
5. The management of supplier networks	15. Managing subcontractor networks
6. Increasing operational efficiencies	8. Combining technical and non-technical expertise (within the organization)
7. Design, testing, piloting of new products, processes, or services	5. Managing the innovation process
8. Use of new innovations	5. Managing the innovation process
9. Protection of intellectual property (for example, embodied in technology, patents, trademarks, components, platforms, or systems)	5. Managing the innovation process
10. Addressing new product or service markets domestically	10. Anticipating markets
11. Addressing new product or service markets internationally	4. Internationalization 10. Anticipating markets 17. Operating in international markets
12. Evaluating and adopting new business models	6. Adopting information and knowledge/knowhow: 3. Strategic business management
13. Abandoning low performing, products, processes, services, units, or markets	3. Strategic business management 5. Managing the innovation process
14. Scanning and networking to stay abreast of technological or other change in the business environment	11. Anticipating technology development 7. Sharing of information and knowledge
15. Scanning and networking to stay abreast of changes to industrial standards, regulations, or other conformance requirements	6. Adopting information and knowledge/knowhow 7. Sharing of information and knowledge
16. Research, development , or innovation (RDI) engagement with other actors (e.g. collaboration or contract RDI with other companies research institutes or universities)	8. Combining technical and non-technical expertise 9. Interdisciplinary combination of expertise 13. Utilizing R&D Networks
17. Acquiring resources to support development of new products or services, or to support expansion	5. Managing the innovation process 13. Utilizing R&D Networks
18. Working with third-parties to enhance products, processes, services, or overall organizational performance	5. Managing the innovation process 13. Utilizing R&D Networks
General	1. Creating value for business and customers 2. Achieving/creating business growth 3. Strategic business management

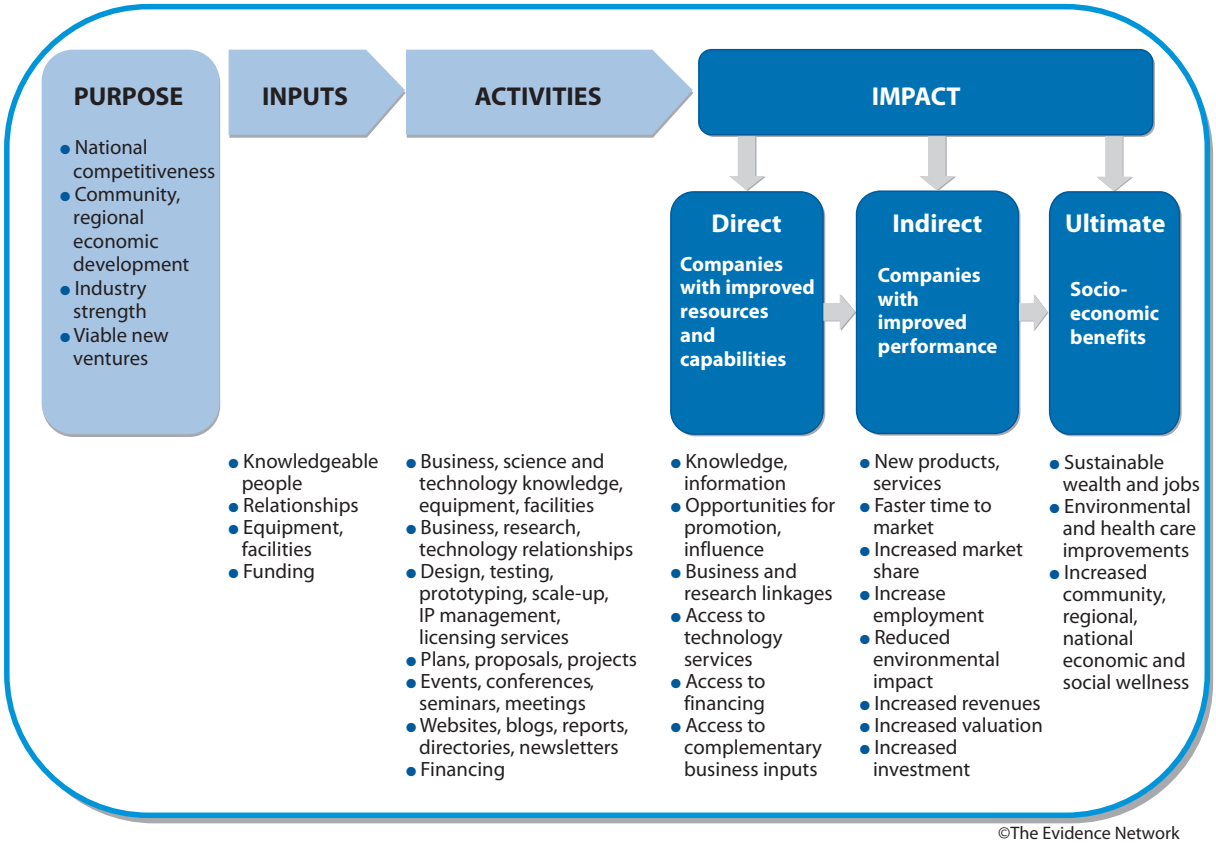
Appendix D. TEN's Impact Assessment Methodology

TEN's approach to measuring innovation impact is based on the premise that innovation intermediaries can be described as an overarching class of organizations whose members share common goals. Despite their diversity, innovation intermediaries, ranging from small economic development organizations to large and sophisticated research institutes, seek to make their member or client companies more innovative, in the interests of facilitating increases in their viability, profitability, or other manifestations of their success.

The logic model shown below illustrates how innovation intermediaries work to fulfill their missions, and how TEN measures their impact. As shown at the top-left of the diagram, innovation intermediaries express their purpose in terms of national competitiveness, regional economic development, industry strength, or viable new ventures, and conduct activities to achieve direct impact on companies' resources and capabilities, indirect impact on companies' performance, and long-term impacts in the form of socio-economic benefits. The direct impact of innovation intermediaries are improvements in the resources or capabilities of client or member companies, indirect impacts are improvements in market performance of client or member companies, and long-term impacts affect communities, industries, economies, societies, and the environment.

Working backwards, from right to left, the logic model shows *how* different types of impact are achieved. The achievement of long-term, or ultimate, impacts depends on the achievement of impacts on company performance, which in turn depends on the achievement of direct impact on companies' resources and capabilities. So, for example, an innovation intermediary that seeks to create economic growth in a region (its purpose and desired long-term impact) does so by facilitating improvements in the performance of local companies (its desired impact on companies' performance), either by facilitating company growth, creating new ventures, or by attracting new companies to the region. It facilitates company growth and the creation of new ventures by facilitating improvements in the resources

TEN's Innovation Intermediary Logic Model



and capabilities of local companies (its desired direct impact). The fundamental logic is that innovation intermediaries achieve their desired impacts on company performance and long-term impacts by affecting the resources and capabilities of the companies with which they work.

TEN measures the intensity of use of intermediary services, and the direct impact and indirect impact on company performance of innovation intermediaries.

By measuring direct impact on resources and capabilities TEN provides intermediary managers, boards of directors, and funders with timely feedback on the suitability and effectiveness of intermediary services. Note that we measure direct impact on resources and capabilities by asking about the *impact* of intermediary services on specific company resources and capabilities, not by asking about *satisfaction* with intermediary services, as a customer satisfaction survey would do. While clients may be satisfied with an intermediary's networking event, the event may or may not have had an impact on their ability to find, for example, new suppliers.

By measuring indirect impact on companies' market performance, TEN provides management, investors, and other stakeholders with evidence of the effect of intermediary services on company performance in terms of new products and services, employment, or revenues, etc. Measuring impact on companies' market performance is important because it corresponds to the missions of intermediaries and provides the hard evidence of results that stakeholders seek. But company performance depends on a number of factors and so to assess indirect impact on company performance we consider both the change in company performance and the degree to which the change is attributable to the intermediary. For example, to determine the impact of a research institute on the revenues of client companies, we ask about both changes in revenues and the degree to which those changes are attributable to the services of the research institute.

Innovation intermediaries hope to have long-term impacts that correspond to their missions. But the measurement of long-term impact is difficult because changes in the economy, the environment, or society are brought about by the collective actions of many players. So it is difficult to attribute such changes to the activities of a single organization. But as long-term impact is facilitated by the achievement of impact on market performance, evidence of impact on companies' market performance is suggestive of possible long-term effects.

TEN's logic model expresses the expectation that services create direct impact and that direct impact on company resources and capabilities will lead to subsequent impacts on company performance, an expectation that holds across all types of innovation intermediaries. Details of how innovation intermediaries achieve their desired impact are shown in the lower part of the diagram. Knowledge-based and tangible inputs lead to a wide range of activities such as provision of knowledge, relationships, events, publications, prototypes, equipment, and facilities. The activities are expected to lead, in turn, to direct impacts, impacts on company performance, and long-term impacts described above.

Statistical examinations of the relationships between use of services, direct impact on resources and capabilities, and impacts on company performance make it possible to assess which services and direct impacts are significantly related to the impact of the intermediary on companies' performance in the market.

TEN measures the intensity of use of services, and direct and indirect impact on company performance using a customized survey instrument. Our impact assessment surveys are short and easy for member or client companies to complete. Assessments can focus on a single organization, can compare actual to targeted performance, or can compare the performance of multiple units, divisions, or organizations.

Appendix E. Description of Sample

The following tables provide information on the relationship between the number of invitations sent to potential respondents and the number of individuals that actually responded to the survey.

The company survey was launched on 28 October 2014 and companies were able to respond until 24 November 2014.

Survey Response Profile of Companies	
Number of Invitations sent to companies	558
Number of e-mail reminders to non-respondents sent by TEN	5
Number of companies that entered the survey website	230
Number of companies that provided survey responses	205
Number of partial responses	51
Response Rate	37%

Thirty-nine percent (39%) of all respondents took 20 minutes or less to complete the survey, having an average time-to-complete of 13.4 minutes. From the distribution with the time-to-complete measure, it is evident that the remainder of respondents were distracted or did not provide responses to remaining questions.

The research organization survey was launched on 6 November 2014 and organization representatives were able to respond until 24 November 2014.

Survey Response Profile of Research Organizations	
Number of Invitations sent to organizations	1163
Number of e-mail reminders to non-respondents sent by TEN	4
Number of organizations that entered the survey website	631
Number of organizations that provided survey responses	583
Number of partial responses	66
Response Rate	50%

Forty-three percent (43%) of all respondents took 18 minutes or less to complete the survey, having an average time-to-complete of 12.1 minutes. From the distribution with the time-to-complete measure, it is evident that the remainder of respondents were distracted or did not provide responses to remaining questions.

Appendix F. Examples of Questions for Companies

Examples of questions used by The Evidence Network to elicit the degree of importance of capabilities, the degree of change pertaining to capabilities, and the sources of change are shown below.

Degree of Importance

This example pertains to the 'Degree of importance' of the capabilities.

The question focuses on the degree of importance of the capabilities. Rating scales are as follows: critical importance, important, unimportant.

Research, development, or innovation (RDI) collaboration capabilities

Examples include capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.

To what degree is this capability important for firms in your industry? Please choose one of the following responses:

- *This capability is of critical importance*
- *This capability is important*
- *This capability is unimportant*

Degree of Change

This example pertains to the 'Degree of change' experienced for each of the capabilities.

The question focuses on the degree of change of the capabilities. Rating scales are as follows: improved, stayed the same, declined.

Research, development, or innovation (RDI) collaboration capabilities

Examples include capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.

Since receiving Tekes support, how have your company's RDI collaboration capabilities changed?

Our company's RDI collaboration capabilities have:

- *Improved*
- *Stayed the same*
- *Declined*

Sources of Change

This example pertains to the 'Sources of change' experienced for each of the capabilities.

The question focuses on the sources of change for the improvements to the capabilities. Respondents were encouraged to select all sources of change that apply.

Research, development, or innovation (RDI) collaboration capabilities

Examples include capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.

Which of the following led to improvements in your company's RDI collaboration capabilities? Please select all that apply.

- *Upgrading of human resources*
- *New organizational processes, equipment, or infrastructure*
- *Pursuit of a new strategic objective that required new capabilities*
- *Tekes financial and non-financial support*
- *Learning from SMEs*
- *Learning from research organizations*
- *Other (please specify)*

Appendix G. Examples of Questions for Research Organizations

Examples of questions used by The Evidence Network to elicit the degree of importance of capabilities, the degree of change pertaining to capabilities, and the sources of change are shown below.

Degree of Importance

This example pertains to the 'Degree of importance' of the capabilities.

The question focuses on the degree of importance of the capabilities. Rating scales are as follows: critical importance, important, unimportant.

Ability to access research funding

Examples include capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.

To what degree is this capability important for your organization? Please choose one of the following responses:

- *This capability is of critical importance*
- *This capability is important*
- *This capability is unimportant*

Degree of Change

This example pertains to the 'Degree of change' experienced for each of the capabilities.

The question focuses on the degree of change of the capabilities. Rating scales are as follows: improved, stayed the same, declined.

Ability to access research funding

Examples include capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.

Since receiving Tekes support, how has your organization's ability to access research funding changed?

Our ability to access research funding has:

- *Improved*
- *Stayed the same*
- *Declined*

Sources of Change

This example pertains to the 'Sources of change' experienced for each of the capabilities.

The question focuses on the sources of change for the improvements to the capabilities. Respondents were encouraged to select all sources of change that apply.

Ability to access research funding

Examples include capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.

Which of the following led to improvements in your organization's ability to access research funding? Please select all that apply.

- *Upgrading of human resources*
- *New organizational processes, equipment, or infrastructure*
- *Pursuit of a new strategic objective that required new capabilities*
- *Tekes financial and non-financial support*
- *Learning from companies*
- *Learning from other researchers or research organizations*
- *Other (please specify)*

Appendix H. Additional 'Other' Responses to Questions from Companies

Investment Allocations – 'Other'

- Test materials
- Consumables
- Travelling
- Prototypes
- Travel
- Travel, books, electronics and other minor material purchases related to research
- Reagents, travelling
- Travel costs
- Travel
- Excursions
- Stainless steel material
- Test runs in our own premises or in other company's facilities
- Customer-oriented sustainable development and innovations in indoor environments.
- Travels
- Development specific raw material
- Travel to Tekes project meetings, related dissemination events
- Minor travelling and chemical costs
- Traveling etc.
- Travel, tools, accessories
- Operations, logistics & sourcing (have used..... 2–5 years ago)
- Materials for research
- Knowledge sharing
- Travel and networking

Investment Rationale – 'Other'

- Methodological capabilities
- Improvement of Know-How
- We are an intermediary organization, not a company. Thus we have used Tekes support in all of these areas but in a more general coordinative level.
- Improve the quality and broaden the scope of research & technology development projects
- Knowledge development
- Risk research
- Maintain relevant basic research on national level (support for research institutes)
- Research, process development
- SME and university subcontracting
- R&D collaboration
- Introducing new company strategy and new company culture to the employees
- High risk research into technologies that are not yet ready for production
- Scale up research and development in selected areas
- Strengthen user orientation
- Strengthening research capabilities
- Get competencies and know-how not existing in-house
- Initiation of projects in new technology areas
- Create international R&D network
- Development of new enabling technologies

Cause of Improvements to Customer Engagement Capability – 'Other'

- Evidence based knowledge

Cause of Improvements to Domestic Market Capabilities – 'Other'

- Tekes funding enabled us to conduct a user study among a good selection of customers in relation to conducted research & technology development work
- Evidence based knowledge in indoor environments.
- Ecosystem of people and companies

Cause of Improvements to International Market Capabilities – 'Other'

- Tekes programs

Cause of Improvements to Promotion and Communication Capability – 'Other'

- Tekes programs and interaction with EU programs
- External customer communication has been improved due to successful implementation of projects
- New organizational technology know-how

Cause of Improvements to Knowledge Management Capability – 'Other'

- Especially joint development with research organizations has lead into knowledge capital increase.
- Collaboration with public service providers
- Scientific publications and international co-operation, Tekes programs, EU programs.

Cause of Improvements to Supply Chain Management Capability – 'Other'

- Collaboration with end users
- Generally, holistic management of the services and effective interaction with the customers.
- Understanding the importance of value chain management and the obstacles in that more closely

Cause of Improvements to Operational Efficiency Capability – 'Other'

- The improved business strategy has been important to the capabilities.
- Better use of knowledge between departments in the company, people work better together and share their information

Cause of Improvements to Product Design, Prototyping, or Testing Capability – 'Other'

- More research resources
- Learning from end users
- Piloting and demonstration in Tekes scientific programs

Cause of Improvements to IP Protection Capability – 'Other'

- Increased know-how has improved the protection capabilities.
- Understand the importance of research agreement and IPR better.

Cause of Improvements to New Business Model Capability – 'Other'

- Developed business strategy and co-operation with the other companies and institutes participating the Tekes programs have improved the capabilities.

Cause of Improvements to Business Environment Capability – 'Other'

- Collaboration with other industrial players in the field through joint programs
- Co-operation projects within Finland have been very rewarding what comes to this aspect
- Program internal events
- Global co-operation in Tekes programs

Cause of Improvements to Regulatory Conformance Capability – 'Other'

- Own actions independent
- Training and co-operation

Cause of Improvements to RDI Collaboration Capability – 'Other'

- Learning from end users
- New evidence based knowledge, scientific publications and global co-operation in Tekes and EU programs
- EU funding
- Get a better picture of VTT capabilities

Cause of Improvements to Financial Resources Capability – 'Other'

- Sale of loss making business unit, improved cash situation, easier access to capital market

Cause of Improvements to Competency Management and Development Capability – 'Other'

- Training and studies, improve the knowledge together with the research institutes and the universities

Industrial Sector – 'Other'

- Social Welfare Services within the Municipality
- We cover several metal, machines, electro-technical, electronics, IT, consultancy.
- Machinery
- Chemical
- Consultancy
- Oil
- Structural design
- Building services consulting firm
- Production traffic biofuels
- Research infrastructure ICT including support for SMEs
- Manufacturing of high-end growing mediums, plant fertilizers and mulches.
- Wind power / services over the life span
- Food and beverage
- Chemistry
- Biotechnology
- Industrial process automation
- Pharma industry

Headquarters Location – 'Other'

- Washington, USA
- Germany
- Germany
- USA

Appendix I. Additional 'Other' Responses to Questions from Research Organizations

Investment Rationale – 'Other'

- Conducted research work
- Doing research within the project, according to the project plan
- Creating new knowledge, strategies and operational models for companies and with companies
- Creating expertise and models that are now transferred and tailored to four industrial companies
- Creating new knowledge and skills (odd that this is not an option in your questionnaire)
- Research visits abroad
- Salaries of the main research staff as the university resources became suddenly nonexistent
- Construct new research equipment for a research facility
- Development of a basis for the foundation of a start-up SME
- Researcher mobility, exchange of researchers. Company expert mobility, providing research opportunities for company experts
- Reading literature, collecting data, analyzing data, and writing articles and conference papers
- Actual research activities
- Bringing on-the-edge fuzzy logic systems, visual communication and narrative research to broadcasting companies
- Conducting research to generate IP
- Academic research
- SME research
- Research & Development
- Offering both research and every day services to SMEs
- Conducting research (research project funding)
- Tech transfer via research results to partner companies
- The main purpose of Tekes projects for us is conducting research, i.e., investigating new technologies. Why this is not in the list???
- Doctoral student and postdoctoral training
- Development of process for production
- Research expenses
- Enhancing existing collaboration networks
- R&D
- Innovation development
- Scientific research
- Research work
- Running experimental research
- The money was mainly used into research, categories asked were insignificant. Or does "human resources" mean research?
- Improving SMEs and large companies quality and decreasing production cost
- Research
- Create novel technical enablers
- Research/measurement campaigns together with private and public partners
- Creating new methods to collect data
- Implement the research relevant to industries, exploration of new cross-disciplinary research areas, maintaining top-research in our organization, concrete tools for collaboration with companies through funding, expanding the scope, strategic level and impact possibilities of development projects with companies
- Improved current or future products, ideas to new offering
- Proof-of-Concept experimentation within the Business Value Network
- Research exchange abroad
- Research work
- Research of the topics agreed with companies or organizations
- R&D work
- Doing research
- Commercialization of research results the above selected use is purely related to preparation of commercialization e.g. it was not used in research context.

Cause of Improvements to the New Research Models Capability – 'Other'

- The models created in the Tekes project has enabled us to negotiate partnership with commercial implementers of the models
- Researcher and company expert mobility. Multi and Trans-disciplinary projects.
- Tekes financial support has enabled a new tool to be applied
- Joint inventions

Cause of Improvements to the Implement Relevant Research Capability – 'Other'

- Research exchange and trans-disciplinary.
- Self-gaining practical know-hows
- Individual learning and development of researchers
- Reduced financial support forces us to cut research and concentrate efforts into selling contract fabrication services to companies. That is currently the "relevant research".
- Tekes funding has been essential for being able to perform research.
- Creation of technology foresight
- Ability to research and pursue commercial use of previous research. There are no incentives nor really good motivators to do this currently without speicific Tekes support, on the contrary, it would not be considered that relevant at all. Tekes instrument to prepare commercialization is a big motivator to utilize research results for the benefit of the economy.

Cause of Improvements to Design Research Project Capability – 'Other'

- Strong point in Tekes funding process is ability to negotiate and improve applications. This leads better control of strategic research directions comparing to funding organizations that just receive applications.
- The use of standards in development
- Researcher exchange. Conference participation and taking part to EU activities.
- Getting more experienced in designing projects
- Lessons learned from preceding experiences
- Learning by doing
- Teamwork, organizational commitment

Cause of Improvements to the Publish in International Journals Capability – 'Other'

- University´s policy is to publish
- Research exchange
- Great industrial partners and good collaboration in the project
- Ability to build needed research networks for co-authored publications
- To have an access to data explaining relevant or emerging phenomeno9n
- Obtaining research data
- In-house training
- Tekes funding has been important for us and the results are published in international peer reviewed journals/conferences.
- Learning

Cause of Improvements to Influence to International Research Agendas Capability – 'Other'

- Researcher exchange. Multi- and Trans-disciplinary.
- Tekes co-financing of international research funding and the contacts that come with this.
- Publishing results and gaining international recognition
- Networking
- Networking with other research organizations, promoting our expertize

Cause of Improvements to the Attract HQP Capability – 'Other'

- Researcher exchange. Collaboration with companies and other research organizations.
- Media coverage, activity in social media
- Financial ability to hire personnel that grew during the project as *cross-disciplinary* experts between art, design, science and technology.
- Results of research including publications, international conferences, other research achievements. They cannot be counted on Tekes funding since the start of SHOK's as after that 90 % of quality publications have been published on other funding sources.
- Branding
- Increased reputation
- Possibility to conduct relevant, interesting research projects.
- Scientific success attracts more interested people
- Bad financial situation in general has increased the amount of applicants.
- Funding is essential for attracting talented researchers.

Cause of Improvements to the Access to Experiment Resources Capability – 'Other'

- Collaboration within research organizations and companies.
- International co-operation partly funded by Tekes.
- Collaboration fostered by Tekes funding
- Access to potential future customers, and prototype(s) built by internal and external resources.

Cause of Improvements to the Access to Research Funding Capability – 'Other'

- Newsletters from Tekes
- Collaboration with other research organizations and EU.
- Change of Tekes funding instruments have resulted in situation where other funding sources have become much more important than Tekes.
- Becoming more savvy of EU programs and how they work.

- Taking part in large consortia through involvement in SHOK programs
- Improved networks and visibility of research.
- New competences and results reached with Tekes funding
- New contacts with research organizations
- Learning from past failures and successes
- Learning by doing

Cause of Improvements to the Problem Solving Capability – 'Other'

- Expertise gained during the Tekes project
- Global standardization
- Multi-, Cross-, and Trans-disciplinary.
- By increasing understand of the studied phenomenon
- Allows further developing our own ideas
- Lessons learned from previous experiences

Cause of Improvements to the Advancement of Research Results Capability – 'Other'

- The models created in the Tekes projects are demonstrated on different platforms prodding thus great interest in industry
- Using the equipment of other partners.
- The help from the research support team of our University
- Learning by doing
- Lessons learned from previous prototypes
- Teamwork, multidisciplinary approaches

Cause of Improvements to the IP Protection Capability – 'Other'

- Help provided by the research support team of our university
- Publications
- Tekes funding and guidance has taught us to identify ideas etc that would require IPR protection. Initial actions towards patenting have also occasionally been taken.

Cause of Improvements to the Promote Research Results Capability – 'Other'

- Multi-, cross- and trans-disciplinary.
- Researchers' activity in social media use
- Marketing channels of the companies, ability to hire artists, designers and actors to develop "content" (game/narrative) engines.
- Networking, participating in SHOKs
- New networks were available to promote the research results
- By increasing possibilities to promote studies and achieved results
- Earlier there was very useful Tekes provided support e.g. the Serve Research Brunch
- Tekes program-specific events and general promotion; Tekes networks.
- Contacts, networking with practitioners in the field
- Public visibility and contacts
- Presentations in seminars, publications
- Doing it
- Resources for traveling
- Research promotion came part of the process with the partners and other involved with this topic
- SHOKS, especially FIMECC

Cause of Improvements to the Disseminate Research Results Capability – 'Other'

- Multi, cross and trans-disciplinary and company experts exchange.
- Good international collaborations and their (and own research team's) active involvement in promoting results in social media etc.
- Company marketing channels, hired professional performing artists with a public interest.
- Enable to disseminate the achieved results
- Tekes program-specific events and general promotion; Tekes networks.
- Individual preferences of the researchers has changed and developed toward international top ranking publications
- Learning from public sector (municipalities)
- Learning by doing
- Doing it
- Resources for traveling
- SHOK, especially FIMECC

Cause of Improvements to the Commercialization of Research Results Capability – 'Other'

- The models created in the Tekes project has enabled us to negotiate partnership with commercial implementers of the models; and four industrial implementation already done
- Trans-disciplinary and use of company experts in research.
- Grass-root movements (e.g. Start-up Sauna)
- Start-up generation.
- Doing it

Cause of Improvements to the National Research Participation Capability – 'Other'

- Improved the co-operation with national universities and research laboratories.
- Multi-, cross and trans-disciplinary.
- Networking with other members in networks

- To be recognized as a relevant research partner
- Participation and networking through e.g. SHOK companies
- Networks created within projects and programs
- Increased possibilities for networking
- Networking
- SHOKs
- Collaboration and events
- Improved travel possibilities

Cause of Improvements to the International Research Participation Capability – 'Other'

- Joining the Annex-work
- Improved greatly the co-operation with international universities and research units.
- Learning from standardization organizations
- Multi-, cross- and trans-disciplinary
- This will be more important in the future
- Becoming more ambitious.
- Accumulation of international networks through project work.
- Learning by doing. You must have something to offer to an interesting partner.
- Results obtained in Tekes-funded projects
- Increased competition regarding international funding
- Learning by doing
- Improved travel possibilities
- Good results from projects funded by Tekes and their links to abroad have increased our credibility and value among international research networks.

Cause of Improvements to the National Research Leadership Capability – 'Other'

- Better networks already from starting point
- Consortium had big enough critical mass to develop and lead new national networks and co-operation.
- Connections to global networks for development of digitalization
- Multi-, cross- and trans-disciplinary

Cause of Improvements to the International Research Leadership Capability – 'Other'

- Joining the Annex-work
- Consortium had big enough critical mass to develop and lead new international networks and co-operation.
- EU projects, international company research and multi, cross and trans-disciplinary.
- Tekes participation in internal research funding.
- Networking
- Changed H2020 funding for coordinators favor flat organizations like Laurea
- Learning by doing
- Enhanced international networking and experiences in national project management have lowered the threshold to coordinate international activities.

Cause of Improvements to the Conduct Research with Companies Capability – 'Other'

- Trans-disciplinary
- Active contacting to find new partners, arranging workshops and seminars for companies
- Tekes regulations to have at least one industrial partner within the project
- Networking with companies
- All Tekes projects involve companies.
- Increased trust with successful projects leads to new orders/projects
- Learning by doing
- Doing it
- Tekes model of funding academia requests for conducting research with companies
- Tekes funding instruments are by far the most appropriate and, on the pragmatic level, the least laborious application instruments for such activities.

Impact of Funding on Research Capabilities – 'Other'

- Innovation
- From a university point of view, Tekes support is essential to open new research directions and even to maintain the existing important research work and personnel.
- Collaboration in global standardization network
- Trans-disciplinary and internationalization.
- International
- Ability to fund multidisciplinary research, teams of scientists, engineers, artists and designers.
- Societal impact
- Networking capabilities improved
- New potential for commercialization based on obtained research results
- International networks
- Business co-operation
- Tech transfer to private sector
- Not possible without external funding
- Broadening of collaboration networks
- Downscaling of scientific goals due to Tekes funding policy
- Internationalization
- Preparation of transfer from research results to commercial applications
- International collaboration
- Get new ideas to improve teaching
- International networking
- Networking

- Tekes is a repulsive partner because of its bureaucracy, arrogance and a low of contribution and value. At this phase of my career I am happy not to involve Tekes funding. The pay-pack of other research activities is more fruitful.
- International skills
- Networking
- Boosting international collaboration
- Emphasis on evidence based applications of the research
- Finding new high-tech partners from Finland with Tekes Specialists, mainly small companies, which are not commonly known often hiding
- Agility
- Reputation
- Possibility to recruit junior researchers, like Master's Thesis workers. Funding commitment unsuitable for more senior staff.
- Aiming for Tekes funding has improved the capabilities to find and communicate with companies with interests common to your own ones.
- Get new ideas to improve teaching

Respondent Type – 'Other'

- I represent publically and private funded research organization
- Ex research project manager
- I represent a research unit of a research organization
- I represent a production unit of a research organization
- I represent a privately-funded research organization
- Head of department, university of applied sciences
- Representative of separate department of university
- Previously senior researcher at a university
- Emeritus
- University of Applied Sciences representative
- I am applied university representative
- Partly public funded CRO (contract research organization)
- Private research organization

Appendix J. Regression Analysis

In this section, we consider the question of what is improving capabilities. To do so, we conduct statistical examinations of the relationships between the capabilities measures and predictors of the improvements on capabilities. We consider two kinds of predictors: company/research organizations attributes, and the impact of internal mechanisms that we include as control variables, and the impact of external mechanisms on overall capabilities.

Though we conducted individual tests for each capability measure[18], we only report the findings of those capability models that have a R^2 value of 20% or greater.[19] Models with a higher R^2 value are better and more accurate in explaining the variance in the dependent variable, capability measures, from our independent variables. In addition, we are interested in the impact of external mechanisms on improvements to capabilities; therefore, we focus on reporting the results of external mechanisms variables.

Company Capabilities

In this section, we present findings of five models that have a R2 value of 20% or greater with regard to company capability measures, which specifically are New business model, Operational efficiency, Market capabilities (domestic), Research, development, or Innovation (RDI) collaboration, and Knowledge management. A summary table presenting all analysis findings is also included for a more fulsome representation of the regression findings.

The regression analysis indicates that companies that reported that the new business model capabilities were of greater importance are more likely to attribute Tekes with impact on improvements to their new business model capabilities.

Additionally, it is the external mechanisms related to Tekes funding that better predict the improvements to companies' operational efficiency capabilities. This means that as the amount of funding increases, so do the improvements to companies' operational efficiency capabilities.

Further, companies that engage with SMEs to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to domestic market capabilities, and with impact on their improvements to knowledge management capabilities.

In addition, companies that engaged with research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to RDI collaboration capabilities.

Moreover, it was found that growing companies are more likely to attribute Tekes with impact on improvements to their operational efficiency capabilities, and as well as with impact on improvements to their domestic market capabilities.

Further, companies with headquarters outside of the Uusimaa region are more likely to attribute Tekes with impact on their improvements to operational efficiency.

Finally, it was determined that internal mechanisms related to new strategy objectives also predict improvements to companies' domestic market capabilities.

In the following we describe the measures, and provide a summary table that shows the results of all of the linear regressions against improvements on companies' capabilities.

Control Variables – Company Attributes, and Internal Mechanism

We control for eight company attributes, and three internal mechanisms that may impact companies' assessment of the impact of external mechanisms on their overall capabilities:

Company Attributes

- **Importance of capability:** Respondents were asked to indicate the perceived importance of each of the 15 capabilities measures, as identified by the respondent companies. It is an ordinal variable taking the value of 2 if it is 'Critical important'; taking the value of 1 if it is 'Important'; or taking the value of 0 if it is 'Unimportant'. The following table shows the 15 measures, and their associated examples, that were selected to assess companies' capabilities.
- **Age:** Indicates the company's age in years in 2014 and has an average value of 29.02 years (all companies formed prior to 1982 were considered to be formed in 1982).

[18] In total, there are 15 company capability measures and 19 research organization capability measures.

[19] R^2, also known as the coefficient of determination, is a statistical measure of how close the data is to the fitted regression line. It is the percentage of the response variable variation that is explained by a linear model (i.e. R^2 is equal to the explained variation divided by the total variation). It is always between 0% and 100%. 0% indicates that the model explains none of the variability of the response data around its mean. 100% indicates that the model explains all of the variability of the response data around its mean. In general, the higher the R^2, the better the model fits its data.

Capabilities Measures.

Capabilities Measure	Examples
Customer engagement	Connecting with existing or potential customers and end users to elicit information or feedback on how your company's products, processes, or services can be improved to address unmet market or societal needs.
Market capabilities (domestic)	Gathering intelligence (such as market studies etc.) relevant to your company's markets within Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Market capabilities (international)	Gathering intelligence (such as market studies, e.g. with other Team Finland partners) relevant to your company's markets outside Finland, together with the ability to analyze and take action for the purposes of market expansion, product or service differentiation, management of distribution channels, etc.
Promotion and communication	The capacity to increase visibility or raise awareness of your company's products, processes, or services (e.g. digital marketing, participating at networking or partner events, media outreach, etc.).
Knowledge management	The management of new knowledge or information related to, for example, technology, products, processes, or services that help to accelerate your company's strategies.
Supply chain management	The design, planning, execution, control, or monitoring of supply chain activities with the objective of creating added value, building a competitive infrastructure, and leveraging logistics, while managing the flow of goods and services through your supplier networks.
Operational efficiency	Improvements to the efficiency of your organization's human resources, fixed assets or service acquisitions, financial investments, process-related, or other business practices.
Product design, prototyping, or testing	Design, test, or pilot new products, processes, or services, through the use of specialized equipment, software, technology, etc.
Intellectual property protection	To ensure the protection or management of intellectual property, such as the use of patents, industrial design rights, trademarks, copyrights, process innovations, trade secrets, or rapid product creation and deployment, etc.
New business model	Evaluate, develop, test, or adopt new business models to augment or change your company's value proposition, transform your revenue- generating model, improve cash flow, etc.
Scanning, or networking business environment	Scanning (assembling information), or networking with industry professionals, customers, suppliers, partners, industry associations, etc. to stay abreast of technological changes, customers' needs or requirements, new methods or processes, trends, or other changes in your company's business environment.
Regulatory conformance	Capabilities to stay abreast of industrial standards, regulations, laws or legislation, or other conformance requirements.
RDI collaboration	Capabilities to collaborate, or participate in contract RDI, with other companies, government agencies, research institutes, or universities in an effort to identify or assemble new research resources, analyze or interpret patents or scientific findings, access research facilities or specialized equipment and technology, implement new or significantly improved products, processes, services, or improve overall organizational performance.
Financial resources	Capabilities to raise capital through public or private sources, or secure investments in equipment or technology to support, for example, the development of new products, processes, services, or market expansion, etc.
Competency management and development	Acquiring and retaining human resources (i.e. hiring new employees), developing and managing existing competences, utilizing external competences, etc.

- **Size:** Respondents were asked to indicate the number of employees, including full-time and part-time employees (actual number), and their annual revenues (actual values). The number of employees and the values for the annual revenues responses were multiplied to get an indicator of company size that ranged from a low of zero (companies with annual revenues of 0) to a high of 90,000 billion (about 1 billion of annual revenues and 90,000 employees). The average value of the size indicator was 2,740 billion.
- **Growth:** Companies that are growing may be inclined to be more generous in their assessment of external mechanisms' impact, so we include growth rate as a control variable to distinguish this effect from other explanations of improvements on companies' capabilities. Respondents were asked to indicate their company's change in employment since their first engagement with Tekes on a seven point scale that ranged from a low of 'decreased' (coded as -0.05) to a high of 'increased by 100% or more' (coded as 1.5). Respondents were also asked to indicate

their company's change in annual revenues since their first engagement with Tekes on a seven point scale that ranged from a low of 'decreased' (coded as -0.05) to a high of 'increased by 100% or more' (coded as 1.5). Responses to these questions were used to calculate companies' change in employment and annual revenues since their first engagement with Tekes. The change in employment (increase or decrease in percentage) and change in annual revenues (increase or decrease in percentage) was multiplied together to get an indicator of company growth rate that ranged from a low of -.0185 (employment decreased by 10% (coded as -0.05) and revenues increased between 25% and 49% (coded as .37) to a high of 2.25 (employment increased by more than 100% (coded as 1.5) and annual revenues increased by more than 100% (coded as 1.5)). The average value was.[20]

- **Annual RDI investment:** Indicates the amount of money annually invested in research, development, or innovation. Companies that invest in research, development, and innovation are expected to have a greater absorptive capacity and therefore experience greater improvements on overall capabilities. Respondents were asked to indicate the amount of money annually invested in research, development, and innovation on a seven point scale that ranged from a low of 'no investment' (coded as zero), to a high of 'more than 10 million' (coded as €15 million). The average value was €7.4 million.
- **Uusimaa:** Uusimaa (headquarters' location) is a binary variable with a value of 1 if the company's headquarters are in the Uusimaa region, and 0 otherwise. 108 out of 182 companies headquartered in Uusimaa.
- **Manufacturing industry:** Manufacturing is a binary variable with a value of 1 if the company operates in the manufacturing industry and 0 otherwise. 71 out of 187 companies operate in the manufacturing industry.
- **ICT industry:** ICT is a binary variable with a value of 1 if the company operates in the ICT industry and 0 otherwise. 33 out of 187 companies operate in the ICT industry.

Internal Mechanisms

- **Upgrading human resources:** Indicates the improved in-house expertise or improved ability to leverage expertise. It is an ordinal variables taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; or taking the value of 3 if it is 'Very significant impact'.
- **Organizational improvements:** Indicates the new organizational processes, equipment, or infrastructure. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; or taking the value of 3 if it is 'Very significant impact'.
- **New strategic objectives:** Indicates the pursuit of new strategic objectives that required new capabilities. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; or taking the value of 3 if it is 'Very significant impact'.

Independent Variables – External Mechanism

Our independent variables are the external mechanisms that may contribute to the improvements to companies' overall capabilities:

- **Tekes funding:** Companies that received funding (amount of money received) are expected to have a greater motivation and confidence and therefore experience greater improvements on their overall capabilities. Respondents were asked to indicate the amount of money they received from Tekes. The average Tekes funding received by companies was €445.7K.
- **Tekes support:** Indicates the funding and business support provided by Tekes. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.
- **Engagement with SMEs:** Indicates the degree of companies' engagement with SMEs as a consequence of Tekes support. It is an ordinal variable taking the value of 0 if it is 'None'; taking the value of 1 if it is 'Low degree of engagement'; taking the value of 2 if it is 'Moderate degree of engagement'; and taking the value of 3 if it is 'High degree of engagement'.
- **Engagement with research organizations:** Indicates the degree of companies' engagement with research organizations as a consequence of Tekes support. It is an ordinal variable taking the value of 0 if it is 'None'; taking the value of 1 if it is 'Low degree of engagement'; taking the value of 2 if it is 'Moderate degree of engagement'; and taking the value of 3 if it is 'High degree of engagement'.

Dependent Variables – Measures of the Improvements on Capabilities

Our dependent variable is the improvement on each of the 15 capabilities measures, as identified by the respondent companies.

- **Improvements on capability:** It is an ordinal variable taking the value of 1 if it is 'Improved; taking the value of 0 if it is 'Stayed the same'; and taking the value of -1 if it is 'Declined'.

[20] Six companies indicated that their employment decreased and their annual revenues decreased correspondingly. Instead of calculating this to be positive growth rate, we took the decline in both employment and annual revenues to be negative growth rate, and coded the responses accordingly.

Summary Table: Regression Results of Companies

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.[21]
Importance of capability	4.45***	4.00***		4.27***	4.57***	2.49*	3.94***	3.13**	3.88***	3.29**	2.54*		2.58*	3.30**	3.01**
Age									-2.45*		-1.70α				
Size								1.71α	-2.18*						
Growth		2.10*	2.73**						1.69α		2.23*	2.45*			
RDI investment															
Uusimaa		-2.26*													
Manufacturing															
ICT															
Upgrading human resources						-2.51*						-1.75α			
Organizational improvements															
New strategic objectives			3.15**			1.92α	2.64*								
Funding		2.03*	-2.00*												
Tekes support			-2.46*					1.78α							
Engagement with SMEs			2.50*		1.72α	2.11*		2.11*							
Engagement with ROs				2.37*		1.69α	2.05*			1.89α					
N	117	123	101	125	129	118	128	124	120	111	136	122	133	120	104
F	3.90*** (15 dof)	3.76*** (15 dof)	3.12*** (15 dof)	3.47*** (15 dof)	3.29*** (15 dof)	2.77** (15 dof)	2.74** (15 dof)	2.62** (15 dof)	3.07** (11 dof)	2.35** (15 dof)	2.44** (11 dof)	1.95* (11 dof)	1.85α (11 dof)	1.62 (11 dof)	1.41 (11 dof)
Adjusted R^2	.27	.25	.24	.23	.21	.19	.17	.17	.16	.16	.11	.08	.07	.05	.04

Coefficients are t values; dof = Degrees of freedom, α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

[21] According to numerical order, the 15 capabilities measures are: 1) New business model; 2) Operational efficiency; 3) Market capabilities (domestic); 4) RDI collaboration; 5) Knowledge management; 6) Market capabilities (international); 7) Product design, prototyping, or testing; 8) Competency management and development; 9) Supply chain management; 10) Intellectual property protection; 11) Customer engagement; 12) Promotion and communication; 13) Scanning or networking-business environment; 14) Regulatory conformance; and 15) Financial resources.

Model Results

We seek to understand what is improving companies' capabilities. Linear regression was used to test for a significant relationship between 15 company capability measures and predictors of the improvements on capabilities. Although all 15 models were included in the summary table, we present only the five models with that have a R2 value of 20% or greater with regard to company capability measures. As described in the introduction, models with a higher R2 value more accurately explain the variance in the dependent variable, in this case the capability measures, resulting from the independent variables.

New Business Model Capabilities

- Companies that considered new business model capabilities to be of greater importance are more likely to attribute Tekes with impact on their improvements to new business model capabilities (significant at the 99.9% confidence level).

Operational Efficiency Capabilities

- Growing companies, and companies with headquarters in regions outside Uusimaa, are more likely to attribute Tekes with impact on their improvements to operational efficiency capabilities (both significant at the 95% confidence level).
- Companies that considered operational efficiency capabilities to be of greater importance are more likely to attribute Tekes with impact on their improvements to operational efficiency capabilities (significant at the 99.9% confidence level).
- External mechanisms related to Tekes funding, is a significant and positive predictor of improvements to companies' operational efficiency capabilities (significant at the 95% confidence level).

Linear Regression Against Improvement on New Business Model

	Model 1 Control and External Mechanism
Constant	-1.45
Importance of new business model capabilities	4.45***
Age	-.76
Size	-1.63
Growth	-.09
RDI Investment	-1.37
Uusimaa	-.40
Manufacturing	-.67
ICT	.08
Upgrading human resources	-.01
Organizational improvements	.98
New strategic objectives	.82
Funding	-.50
Tekes support	.74
Engagement with SMEs	1.58
Engagement with research organizations	.38
Model characteristics	
N	117
F	3.90*** (15 dof)
Adjusted R^2	.27

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Linear Regression Against Improvement on Operational Efficiency

	Model 2 Control and External Mechanism
Constant	-1.00
Importance of operational efficiency capabilities	4.00***
Age	.47
Size	-.51
Growth	2.10*
RDI Investment	-.69
Uusimaa	-2.26*
Manufacturing	-1.15
ICT	-1.25
Upgrading human resources	-1.36
Organizational improvements	1.66
New strategic objectives	-.81
Funding	2.03*
Tekes support	1.01
Engagement with SMEs	1.04
Engagement with research organizations	-.31
Model characteristics	
N	123
F	3.76*** (15 dof)
Adjusted R^2	.25

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Market Capabilities (domestic)

- Growing companies are more likely to attribute Tekes with impact on their improvements to domestic market capabilities (significant at the 99% confidence level).
- Internal mechanisms related to the pursuit of a new strategic objective that required new company capabilities is a significant predictor of improvements to companies' domestic market capabilities (significant at the 99% confidence level).
- Companies that engaged with SMEs to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to their domestic market capabilities (significant at the 95% confidence level).
- External mechanisms related to Tekes funding, and Tekes support are significant but negative predictors of improvements to companies' domestic market capabilities (both significant at the 95% confidence level).

Linear Regression Against Improvement on Market Capabilities (Domestic)

	Model 3 Control and External Mechanism
Constant	-.33
Importance of market capabilities (domestic)	1.54
Age	-.01
Size	-1.47
Growth	2.73**
RDI Investment	-.07
Uusimaa	-.54
Manufacturing	.06
ICT	-.16
Upgrading human resources	.17
Organizational improvements	-.55
New strategic objectives	3.15**
Funding	-2.00*
Tekes support	-2.46*
Engagement with SMEs	2.50*
Engagement with research organizations	.41
Model characteristics	
N	101
F	3.12*** (15 dof)
Adjusted R^2	.24

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Research, Development, or Innovation (RDI) Collaboration Capabilities

- Companies that considered RDI collaboration capabilities to be of greater importance are more likely to attribute Tekes with impact on their improvements to RDI collaboration capabilities (significant at the 99.9% confidence level).
- Companies that engaged with research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to RDI collaboration capabilities (significant at the 95% confidence level).

Linear Regression Against Improvement on RDI Collaboration

	Model 4 Control and External Mechanism
Constant	-1.03
Importance of RDI collaboration capabilities	4.27***
Age	.40
Size	-.13
Growth	.97
RDI Investment	.29
Uusimaa	-1.10
Manufacturing	-.37
ICT	-.94
Upgrading human resources	.68
Organizational improvements	-1.23
New strategic objectives	.63
Funding	-.88
Tekes support	.11
Engagement with SMEs	.75
Engagement with research organizations	2.37*
Model characteristics	
N	125
F	3.47*** (15 dof)
Adjusted R^2	.23

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Knowledge Management Capabilities

- Companies that considered knowledge management capabilities to be of greater importance are more likely to attribute Tekes with impact on their improvements to knowledge management capabilities (significant at the 99.9% confidence level).
- Companies that engaged with SMEs to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their improvements to knowledge management capabilities (significant at the 90% confidence level).

Linear Regression Against Improvement on Knowledge Management

	Model 5 Control and External Mechanism
Constant	-1.13
Importance of knowledge management capabilities	4.57***
Age	-.69
Size	-.38
Growth	-.52
RDI Investment	-1.57
Uusimaa	-.32
Manufacturing	.17
ICT	-.13
Upgrading human resources	1.02
Organizational improvements	-.76
New strategic objectives	.94
Funding	-.57
Tekes support	1.14
Engagement with SMEs	1.72α
Engagement with research organizations	1.13
Model characteristics	
N	129
F	3.29*** (15 dof)
Adjusted R^2	.21

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Research Organization Capabilities

In this section, we present findings of four models that have a R2 value of 20% or greater with regard to research organization capability measures, which specifically are Problem solve, Influence international research, Identify relevant research, and Attract highly qualified personnel (HQP). A summary table presenting all analysis findings is also included for a more fulsome representation of the regression findings.

The regression analysis indicated that external mechanisms related to Tekes funding, Tekes financial support, Tekes non-financial support, degree of engagement with SMEs, and degree of engagement with other researchers or research organizations are the best predictors of research organizations' capabilities.

We find that it is the external mechanisms related to Tekes funding which better predict the improvements in research organizations' abilities to identify and implement relevant research.

Further, the external mechanisms related to Tekes financial support better predict the improvements in research organizations' abilities to problem solve, and in their improved ability to identify and implement relevant research.

In addition, the external mechanisms related to Tekes non-financial support better predict the improvements in research organizations' abilities to problem solve, to influence international research agendas, to identify and implement relevant research, and to attract highly qualified personnel.

Additionally, respondents that engaged with other researchers or research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their research organizations' improved ability to influence international research agendas, and ability to identify and implement relevant research.

Finally, it was determined that internal mechanisms related to upgrading human resources also predict the improvements in research organizations' abilities to problem solve, to identify and implement relevant research, and to attract highly qualified personnel.

In the following we describe our measures, and provide a summary table that shows the results of all of the linear regressions against improvements on researchers and research organizations' capabilities.

Control Variables – Research Organization Attributes and Internal Mechanism

We control for three research organization attributes, and three internal mechanisms that may impact researchers and research organizations' assessment of the impact of external mechanisms on their overall capabilities:

Research Organization Attributes

- **Importance of capability:** Respondents were asked to indicate the perceived importance of each of the 19 capabilities measures, as identified by the respondent research organizations. It is an ordinal variable taking of value of 2 if it is 'Critical important'; taking the value of 1 if it is 'Important'; or taking the value of 0 if it is 'Unimportant'. The following table shows the 19 measures, and their associated examples, that were selected to assess research organizations' capabilities.

Capability measures.

Capabilities Measure	Examples
New research models	Capabilities to evaluate or develop new models for the conduct of research, for example, strategic focus on national priorities, increasing the use of multidisciplinary teams, user-pay models, or new strategies to select partners, clients, or funders.
Identify relevant research	Capabilities for the identification of scientific or technological disciplines, business sectors, or community or social imperatives that may determine the focus of individual or organizational research projects relevant to business, and more generally to society.
Design research projects	Capabilities that ensure effective linkages between strategic research directions, research plans, and resource deployment so as to optimize research productivity, such as establishment of realistic expectations in research plans, ensuring harmony between research plans and available personnel and equipment, and effective use of milestones.
International journal publications	Access to leading journals based upon peer review of the quality of research.
Influence international research	Invitations to participate in strategic research deliberations in international forums, participation in international symposia, or provision of expert advice on research matters of international importance.
Attract highly qualified personnel (HQP)	Planning for and management of research, technical, and other supporting personnel to ensure that optimal competencies are available for the conduct of research, present and future, such as competency audits in relation to strategic priorities, and effective recruitment and human resource practices.
Access to experiment resources	Capabilities include access to laboratories, specialized equipment, facilities, or data to support research investigations, creation of prototypes, new compounds, facilities for piloting and scale-up, whether directly available to researchers in organizations or secured from external sources.
Access to research funding	Capabilities to leverage internal or external research funding to increase the scale or scope of individuals' or organizations' research, such as creation of multi-party funding arrangements, development of cross-disciplinary or cross-sectoral project concepts, or using non-research (e.g. financial management) competencies to greater advantage.
Problem solve	Capabilities include those to validate ideas, assess industrial designs, process, or production issues, for example, through access to technical documents or broader literature, on-site consultations, and use of know-how.
Advance research results	Capabilities include knowledge that enables creation of new research ideas, use of tools and techniques for their validation, development of prototypes, knowledge of testing protocols, ability to move from laboratory to larger scales (idea development to new or improved products or services).
Intellectual property protection	Capabilities include the identification of potentially valuable intellectual property, to ensure its protection through the use of patents, publications, documentation of know-how, or capabilities to disseminate intellectual property for use through licensing or other methods.
Promote research results	Capabilities include the capacity to increase visibility or raise awareness of your RDI (research, development or innovation) capabilities, such as through presentations, reports, media outreach, networking events, etc.
Disseminate research results	Capabilities to make research more assessable to individuals, businesses, or communities, such as innovative intellectual property policies, public forums on research findings, schemes to improve spill-over access to findings by competitors, and creative involvement of public institutions to foster both procurement of research-intensive products or services, or provide greater visibility to publically funded research.
Commercialize research results	Capabilities to foster the use of research such as forging research-user relationships for the identification, development, conduct, or deployment of products and services from research projects, syndicating investment in research projects by multiple end-users, or use of personnel who can articulate the benefits of complex research undertakings to less-specialized users.

Capabilities Measure	Examples
National research participation	Capabilities to participate in domestic research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
International research participation	Capabilities to participate in international research networks, consortia, or with groups of researchers that direct efforts toward a common goal.
National research leadership	Initiatives to create or lead new national networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.
International research leadership	Initiatives to create or lead new international networks or consortia that advance RDI that would otherwise be difficult or impossible to do as an individual or organization operating alone.
Conduct research with companies	Capabilities to collaborate with companies or representatives of companies in projects, consortia, contract research, or other means by which collaborative RDI is undertaken.

- **University representative:** Indicates the type of research organization that a respondent represents. It is a binary variable taking the value of 1 if the respondent identified as being a university representative and 0 otherwise.
- **Research organization:** Indicates the type of research organization that a respondent represents. It is a binary variable taking the value of 1 if the respondent identified as being a representative of a publically funded research organization and 0 otherwise.

Internal Mechanisms

- **Upgrading human resources:** Indicates the improved in-house expertise or improved ability to leverage expertise. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.
- **Organizational improvements:** Indicates the new organizational processes, equipment, or infrastructure. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.
- **New strategic objectives:** Indicates the pursuit of new strategic objectives that required new organizational capabilities. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.

Independent Variables – External Mechanism

Our independent variables are the external mechanisms that may contribute to the improvements to companies' overall capabilities:

- **Tekes funding:** Research organizations that received funding (amount of money received) are expected to have greater motivation and confidence and therefore experience greater improvements on their overall capabilities. Respondents were asked to indicate the amount of money they received from Tekes. The average Tekes funding received by companies was €445.7K.
- **Tekes financial support:** Indicates the funding provided by Tekes. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.
- **Tekes non-financial support:** Indicates the business support provided by Tekes. It is an ordinal variable taking the value of 0 if it is 'No impact'; taking the value of 1 if it is 'Some impact'; taking the value of 2 if it is 'Significant impact'; and taking the value of 3 if it is 'Very significant impact'.
- **Engagement with SMEs:** Indicates the degree of research organizations' engagement with SMEs as a consequence of Tekes support. It is an ordinal variable taking the value of 0 if it is 'None'; taking the value of 1 if it is 'Low degree of engagement'; taking the value of 2 if it is 'Moderate degree of engagement'; and taking the value of 3 if it is 'High degree of engagement'.
- **Engagement with large companies:** Indicates the degree of research organizations' engagement with large companies as a consequence of Tekes support. It is an ordinal variable taking the value of 0 if it is 'None'; taking the value of 1 if it is 'Low degree of engagement'; taking the value of 2 if it is 'Moderate degree of engagement'; and taking the value of 3 if it is 'High degree of engagement'.
- **Engagement with research organizations:** Indicates the degree of research organizations' engagement with other researchers and research organizations as a consequence of Tekes support. It is an ordinal variable taking the value of 0 if it is 'None'; taking the value of 1 if it is 'Low degree of engagement'; taking the value of 2 if it is 'Moderate degree of engagement'; and taking the value of 3 if it is 'High degree of engagement'.

Dependent Variables - Measures of the Improvements on Capabilities

Our dependent variable is the improvement on each of the 19 capabilities measures, as identified by the respondent researcher or research organization.

- **Improvements on capability:** It is an ordinal variable taking the value of 1 if it is 'Improved; taking the value of 0 if it is 'Stayed the same'; and taking the value of -1 if it is 'Declined'.

Summary Table: Regression Results of Research Organizations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.[22]
Importance of capability	9.35***	7.28***	4.86***	5.61***	3.79***	4.67***	4.52***	5.39***	4.58***	4.12***
University representative										
Research organization										
Upgrading human resources	2.36*		1.75α	2.82**	2.24*			2.02*	2.40*	2.17*
Organizational improvements										
New strategic objectives								2.52*		2.46*
Funding			2.35*				1.73α			2.54*
Tekes financial support	1.65α		2.56*		1.96α	2.08*		3.00**	2.00*	2.00*
Tekes non-financial support	2.57*	3.65***	4.07***	2.17*	5.86***	4.14***	4.15***			2.27*
Engagement with SMEs								2.06*	2.07*	
Engagement with large companies					-1.83α					
Engagement with Research organizations		1.68α	2.53*		2.76**	4.42***				
N	466	454	481	466	474	471	452	439	474	480
F	12.96*** (12 dof)	11.68*** (12 dof)	11.26*** (12 dof)	10.55*** (12 dof)	10.29*** (12 dof)	9.15*** (12 dof)	8.20*** (12 dof)	7.80*** (12 dof)	8.12*** (12 dof)	7.84*** (12 dof)
Adjusted R^2	.24	.22	.20	.20	.19	.17	.16	.16	.15	.15

Coefficients are t values; dof = Degrees of freedom, α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

	11.	12.	13.	14.	15.	16.	17.	18.	19.[23]
Importance of capability	3.57***	4.02***	5.16***		4.58***	2.66**	5.33***	5.12***	2.90**
University representative				1.79α					
Research organization									
Upgrading human resources									2.29*
Organizational improvements								2.42*	
New strategic objectives		2.60*	3.02**	2.64**					1.75α
Funding			1.91α						2.04*
Tekes financial support	3.34**			2.72**				2.09*	
Tekes non-financial support	2.23*	2.01*		2.12*	3.09**	4.43***	1.96α		3.35**
Engagement with SMEs	1.82α		2.05*		1.99*		1.94α		
Engagement with large companies	2.55*								
Engagement with Research organizations		2.78**		2.96**					
N	480	462	409	453	475	482	366	433	471
F	7.53*** (12 dof)	7.02*** (12 dof)	6.64*** (12 dof)	6.91*** (12 dof)	6.50*** (12 dof)	6.27*** (12 dof)	4.98*** (12 dof)	5.36*** (12 dof)	5.53*** (12 dof)
Adjusted R^2	.14	.14	.14	.14	.12	.12	.12	.11	.10

Coefficients are t values; dof = Degrees of freedom, α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

[22] According to numerical order, the 1-10 capabilities measures are: 1) Problem solve; 2) Influence international research; 3) Identify relevant research; 4) Attract highly qualified personnel; 5) Design research projects; 6) National research participation; 7) International research leadership; 8) Advance research results; 9) Disseminate research results; and 10) International research participation.

[23] According to numerical order, the 11-19 capabilities measures are: 11) Conduct research with companies; 12) National research leadership; 13) Commercialize research results; 14) Create new research models; 15) Promote research results; 16) Access to research funding; 17) Intellectual property protection; 18) Access to experiment resources; and 19) International journal publications.

Model Results

We seek to understand what is improving the capabilities of researchers and research organizations. Linear regression was used to test for a significant relationship between 19 capability measures and predictors of the improvements on capability. Although all 19 models were included in the summary table, we present only the four models with that have a R2 value of 20% or greater with regard to research organization capability measures. As described in the introduction, models with a higher R2 value more accurately explain the variance in the dependent variable, in this case the capability measures, resulting from the independent variables.

Problem Solve

- Respondents that considered ability to problem solve to be of greater importance are more likely to attribute Tekes with impact on their research organization's improved ability to problem solve (significant at the 99.9% confidence level).
- Internal mechanisms related to upgrading human resources are a significant predictor of improvements in ability to problem solve (significant at the 95% confidence level).
- External mechanisms related to Tekes financial support, and Tekes non-financial support are significant predictors of improvements in ability to problem solve (significant at the 90% confidence level and at the 95% confidence level respectively).

Linear Regression Against Improvement on Ability to Problem Solve

	Model 1 Control and External Mechanisms
Constant	-3.76***
Importance of ability to problem solve	9.35**
University	.07
Research organization	-.50
Upgrading human resources	2.36*
Organizational improvements	-1.06
New strategic objectives	.97
Funding	.87
Tekes financial support	1.65α
Tekes non-financial support	2.57*
Engagement with SMEs	-.23
Engagement with large companies	.41
Engagement with research organizations	.64
Model characteristics	
N	466
F	12.96*** (12 dof)
Adjusted R^2	.24

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Influence International Research

- Research organizations that considered ability to influence international research agendas to be of greater importance are more likely to attribute Tekes with impact on their research organization's improved ability to influence international research agendas (significant at the 99.9% confidence level).
- External mechanisms related to Tekes non-financial support is a significant predictor of improvements to in ability to influence international research agendas (significant at the 99.9% confidence level).
- Respondents that engaged with other researchers or research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their research organizations' improved ability to influence international research agendas (significant at the 90% confidence level).

Linear Regression Against Improvement on Ability to Influence International Research Agendas

	Model 2 Control and External Mechanisms
Constant	-4.84***
Importance of ability to influence international research agendas	7.28***
University	1.47
Research organization	1.20
Upgrading human resources	1.22
Organizational improvements	1.05
New strategic objectives	1.38
Funding	.29
Tekes financial support	.09
Tekes non-financial support	3.65***
Engagement with SMEs	.92
Engagement with large companies	.47
Engagement with research organizations	1.68α
Model characteristics	
N	454
F	11.68*** (12 dof)
Adjusted R^2	.22

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Identify Relevant Research

- Respondents that considered ability to identify and implement relevant research to be of greater importance are more likely to attribute Tekes with impact on their research organizations' improved ability to identify and implement relevant research (significant at the 99.9% confidence level).
- Internal mechanisms related to upgrading human resources is a significant predictor of improvements in ability to identify and implement relevant research (significant at the 90% confidence level).
- External mechanisms related to Tekes funding, Tekes financial support, and Tekes non-financial support are significant predictors of improvements in ability to identify and implement relevant research (significant at the 95% confidence level for Tekes funding and Tekes financial support, and at the 99.9% confidence level for Tekes non-financial support).
- Respondents that engaged with other researchers or research organizations to a higher degree, as a consequence of Tekes support, are more likely to attribute Tekes with impact on their research organizations' improved ability to identify and implement relevant research (significant at the 95% confidence level).

Linear Regression Against Improvement on Ability to Implement Relevant Research

	Model 3 Control and External Mechanisms
Constant	-2.57*
Importance of ability to implement relevant research	4.86***
University	.31
Research organization	.40
Upgrading human resources	1.75α
Organizational improvements	-.36
New strategic objectives	1.61
Funding	2.35*
Tekes financial support	2.56*
Tekes non-financial support	4.07***
Engagement with SMEs	.67
Engagement with large companies	-.96
Engagement with research organizations	2.53*
Model characteristics	
N	481
F	11.26*** (12 dof)
Adjusted R^2	.20

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Attract Highly Qualified Personnel (HQP)

- Respondents that considered ability to attract talented graduate students, researchers, and technical personnel to be of greater importance are more likely to attribute Tekes with impact on their research organizations' improved ability to attract talented graduate students, researchers, and technical personnel (significant at the 99.9% confidence level).
- Internal mechanisms related to upgrading human resources is a significant predictor of improvements in ability to attract talented graduate students, researchers, and technical personnel (significant at the 99% confidence level).
- External mechanisms related to Tekes non-financial support is a significant predictor of improvements in ability to attract talented graduate students, researchers, and technical personnel (significant at the 95% confidence level).

Linear Regression Against Improvement on Ability to Attract Talented Graduate Students, Researchers, Technical Personnel

	Model 4 Control and External Mechanisms
Constant	-3.46**
Importance of ability to attract graduate students, researchers, personnel	5.61***
University	.17
Research organization	-.95
Upgrading human resources	2.82**
Organizational improvements	1.30
New strategic objectives	-.14
Funding	.96
Tekes financial support	1.43
Tekes non-financial support	2.17*
Engagement with SMEs	.20
Engagement with large companies	.50
Engagement with research organizations	1.47
Model characteristics	
N	466
F	10.55*** (12 dof)
Adjusted R^2	.20

Coefficients are t values; dof = Degrees of freedom,
α = p < .1, * = p < .05, ** = p < .01, *** = p < .001

Appendix K. Glossary of Terms

Term	Description
A priori	Presupposed without examination or analysis. A priori knowledge can be derived purely from reasoning and does not require additional investigation or evidence.
Aggregate impact	The sum total of the impact attributed to the intermediary for each of annual revenues, employment, investments received, and market valuation.
Benefit-cost ratio	A measure of the total economic benefit of an initiative relative to the cost of carrying it out.
Business model	A description of the way a business creates and delivers value to customers.
Confidence level	Used to describe the reliability of a calculation or estimate. A higher confidence level indicates a more reliable estimate.
Control variables	Variables that remain constant throughout an experiment or investigation in order to determine the effects of changes in other variables.
Correlation	An indicator of a predictive relationship in which at least one variable is related to another. For example, there is often a correlation between the price of a product and the demand for that product.
Cronbach's alpha	A measure of internal consistency that describes how closely a set of items are related as a group. Cronbach's alpha is a coefficient of reliability (or consistency); a reliability coefficient of .70 to .79 is considered "acceptable", .80 to .89 is considered "good", and .90 or greater is considered "excellent". TEN uses Cronbach's alpha to determine the reliability of degree of use factors, direct impact factors, and indirect impact factors.
Descriptive statistics	A quantitative summary of data in an investigation. The mean, median and mode are example of descriptive statistics. TEN uses descriptive statistics to summarize data collected from the clients of innovation intermediaries.
Direct impact	Improvements, within a short timeframe, to company resources and capabilities. TEN examines improvements to resources and capabilities as outcomes of service offerings from innovation intermediaries, such as improvements business linkages.
Distribution	The arrangement of the frequency of occurrence around a particular value.
Factor analysis	A statistical method for determining complex relationships between items associated with specific factors. TEN uses a factor analysis to consolidate impact measures for assessments. This approach reduces the complexity and increases comprehension of impact assessments.
Frequency distribution	A graphical representation of the occurrence of each value within a range of values. TEN often uses this tool to represent the frequency of different answers in response to a particular survey question.
Go-to-market strategy	A process by which a company finds, reaches and delivers value to its initial target customers.
HQP	Highly qualified personnel.
Indirect impact	A change in company performance resulting from changes in company resources and capabilities. TEN investigates changes in company performance metrics attributable to some degree to services provided by innovation intermediaries that increase companies' capacity to perform. For example, change in employment.
In-kind investment	A non-monetary investment of goods or service. In-kind investments may be described in terms of the monetary value of the goods and services provided.
Innovation intermediary	A member of a class of organizations with common goals including the support of innovation. TEN works with innovation intermediaries, ranging from small economic development organizations to large and sophisticated research institutes, who seek to make their member or client companies more innovative, in the interests of facilitating increases in their viability, profitability, or other manifestations of their success.
International leader	A term used to describe a company that would consider itself to rank first in the world in its industry.
Internationalization	The entry of a company into an increasing number of international markets.
Internationally advanced	A term used to describe a company with uncommon capabilities shared by few international competitors.

Logic model	A representation of the relationships between the inputs, outputs and outcomes of a program. TEN's innovation intermediary logic model illustrates how innovation intermediaries work to fulfill their missions, and how TEN measures their impact.
Market pull	A need, identified by potential customers or by market research, for a solution to a problem in the market place. New products or services that solve that problem are referred to a market pull products.
Mean	The average of a set of numbers.
Multinational enterprise (MNE)	Organizations that own or control production or services facilities and other assets in at least one country other than its home country.
Multiplier	A number that quantifies the indirect effects of an activity or process. Multipliers take into account indirect effects that may not be directly or easily measurable.
Primary data	Data collected directly from a source by the person or organization conducting the research. TEN collects primary data from innovation intermediaries and their client companies through an established survey methodology.
Private financing	Financing from an individual or a private institution such as loans or angel investment.
Proof of concept	A manifestation of an idea created with the purpose of demonstrating its long-term feasibility. Some proof of concept examples include product prototypes and product trials for potential customers.
P-value	The P value, or calculated probability, is the estimated probability of rejecting the null hypothesis (H0) of a study question when that hypothesis is true.
R & D	Research and development. Companies may invest in research and development activities with the goal of improving or developing products or procedures.
R2	Coefficient of determination. This coefficient describes how well a data set fits to a regression line or model.
Regression analysis	A statistical method for estimating the relationship between a dependent variable and one or more independent variables.
Resources and capabilities	Factors describing a company's capacity to perform, for example, strategic and operational knowledge.
Scale-up	A substantial increase in the capacity to deliver value to customers. For example, increasing production capacity to meet the demands of a much larger market.
Secondary data	Data that is not collected directly from a source by the person or organization conducting the research. Secondary data, for example a census or published interview, may have been manipulated or summarized by the original researcher.
Significance	The likelihood that a result or relationship is caused by something other than mere random chance. The statistic significance represents the probability that random chance could explain the result. In general, a 5% or lower p-value is considered to be statistically significant.
SME	Small and medium sized enterprises, as defined by the Canadian Trade Commissioner Service, are categorized by size. Small enterprises have less than $10 million in annual sales and less than 50 employees in the service sector or less than 100 employees in the manufacturing sector. Medium-sized enterprises have less than $50 million in annual sales and 101 to 500 employees.
Spillover effects	Effects generated indirectly by an activity that may be difficult to quantify as direct results of that activity.
Standard deviation	An indication of the distance of points in a data set from the average value of that set. A small standard deviation value indicates that the points are distributed close to the average, while a large standard deviation indicates that points vary quite a bit from the average value.
Start-up company	A relatively young company in the early stages of development. Start-up companies served by innovation intermediaries may be in the concept phase, prototyping, or generating first sales.
TEN	The Evidence Network. The Evidence Network is an independent third party company that specializes in impact assessment for organizations that support innovation.
Time to market	The elapsed time between the initial concept stage of product development and when the product is available for sale.
Valley of death	Also 'innovation gap' or ' commercialization gap'. The commercialization gap is a breakdown in process of bringing new technologies to market, caused by a lack of funding or resources or some other factor.
Variance	A measure of how far a set of numbers is spread out. A small variance indicates that numbers in a set are very close to each other, which a large variance indicates that data points are spread out.

Appendix L. Tekes three years after survey data

	Research organizations 03–08	Research organizations 09–10	Research organizations (03–10)	% (03–10)	Large companies 03–08	Large companies 09–10	Large companies (03–10)	% (03–10)
Total number of projects	2 208	493	2 701		1 028	379	1407	
Total funding	516 725 888	178 377 418	695 103 306		389 566 510	172 437 404	56 2003 914	
Average funding/project	234 024	361 820	297 922		378 956	454 980	416 968	
Median funding/project	180 000	265 000			214 000	265 000		
Number of organizations funded	92	65	109		400	226	599	
	n							
Projects under 100k	487	87	574	21%	212	71	283	20%
Projects between 100k and 500k	1 545	296	1 841	68%	603	207	810	58%
Projects between 500k and 1m	153	88	241	9%	120	59	179	13%
Projects over 1m	23	22	45	2%	93	42	135	10%
	sum							
Projects under 100k	32 059 387	4 698 143	36 757 530	5%	13 563 584	4 171 042	17 734 626	3%
Projects between 100k and 500k	350 941 977	80 255 743	431 197 720	62%	144 021 625	53 743 249	197 764 874	35%
Projects between 500k and 1m	100 603 057	59 621 004	160 224 061	23%	82 322 942	41 014 757	123 337 699	22%
Projects over 1m	33 121 467	33 802 528	66 923 995	10%	149 658 358	73 508 356	223 166 714	40%

Tekes' Reviews in English

318/2015 Impact of Tekes on Capabilities. Kimmo Halme, Katri Haila, Brian Barge, Margaret Dalziel, Tarmo Lemola and Antti Hautamäki. 157 p.

315/2014 Impact of Tekes activities on productivity and renewal. Kimmo Viljamaa, Kalle Piirainen, Annu Kotiranta, Hannu Karhunen and Janne Huovari. 106 p.

314/2014 A view to future business opportunities – The Finn family summer trip 2045. 12 p.

312/2014 Innovativeness in Finnish workplaces – Renewing working life to bring Finland to bloom. Tuomo Alasoini, Maija Lyly-Yrjänäinen, Elise Ramstad ja Asko Heikkilä. 39 p.

308/2014 The impact of Tekes Activities on Wellbeing and Environment. A study by Technopolis B.V., VTT and Statistics Finland. Ville Valovirta, Janne Lehenkari, Olavi Lehtoranta, Torsti Loikkanen, and Arho Suominen (VTT); Hanneke Bodewes, Bastian Mostert, Stijn Zegel and Geert van der Veen (Technopolis). 83 p.

307/2014 Verso – Vertical Software Solutions 2006–2010 – Katsaus ohjelman toimintaan. Marit Tuominen, Sari Vähämäki, Kari Ryynänen ja Risto Setälä. 74 s.

306/2014 Innovation policy options for sustainability transitions in Finnish transport. Armi Temmes, Venla Virkamäki, Paula Kivimaa, Paul Upham, Mikael Hildén and Raimo Lovio. 55 p.

301/2013 Fuel cells and hydrogen in Finland – Finnish Fuel Cell Programme 2007–2013. 20 p.

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