REVIEW 335/2017

Attractive innovation environment

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and Takahiro Fujimoto

Tekes

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Tekes Review 335/2017
Helsinki 2017

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.

ISSN 1797-7339
ISBN 978-952-457-627-0

Cover photo Fotolia
Page layout: DTPage Oy

Foreword

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

We have several strengths in our innovation environment such as strong competence, good cooperation between businesses and researchers, good networks and well-functioning infrastructure. Our solid ICT expertise is valued the worldwide.

The Finnish business sector had been adapting successfully to global competition until the recession in 2009. Finland is a small open economy and international attractiveness of our innovation environment is a key objective. This requires well-functioning innovation system but also other factors such as comprehensive reassessment of regulation and taxation, and a change in attitudes. Moreover, the Finnish entrepreneurship should take more actively part to the global value chains in order to boost successive growth.

It has been agreed between Tekes and the Ministry of Employment and the Economy (TEM) that Tekes impact and the achievement of objectives will primarily be monitored through impact analyses and studies of individual target areas. Tekes has two main target areas, which are 1) Globally competitive business and industry; 2) Attractive innovation environment. Assessments implemented in each target area and impact studies presenting their results comprise the actual and official method for monitoring Tekes success and impact.

The purpose of this study was to produce a combined ex post and forward-looking evaluation analysis of how Tekes and Team Finland collaborators with Tekes will succeed in reaching its objectives related to goals of the attractive innovation environment. Several ex post evaluation insights were used to measure already produced results and impacts. Second goal of the study was to take a perspective of those factors of innovation environment that are essential to the Finnish economy and society to become attractive at the top level internationally.

This study was carried out by Synocus Oy. Tekes wishes to thank the writers for their thorough and systematic approach. Tekes expresses its gratitude to steering group and all others that have contributed to the study.

Helsinki, March 2017

Tekes – the Finnish Funding Agency for Innovation

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Executive summary

The ambition of the Finnish research and innovation policy is to create sustainable growth and wellbeing. In seeking means to accomplish this objective, the Finnish government has identified several challenges (Research and Innovation Council, 2014):

- The structural change of the Finnish industries and business sector
- The prolonged recession
- Reduced economic resources
- The long-standing strengths are not enough to tackle the crisis
- Limited confidence in Finland as an innovation-driven economy.

This suggests that Finland's strengths must be translated into practical advantages, commercial success stories, and new jobs. This impact study has been done to produce a forward-looking evaluation analysis of how Tekes and Team Finland, as well as their collaborators, will succeed in their objectives related to the goal of making Finland an attractive innovation environment. The impact study takes into consideration those factors of innovation environments in the Finnish economy and society essential to Finland becoming one of the world's most attractive countries in respect of innovation.

The first mention of the notion of an attractive innovation environment in the agreement between Tekes and the Ministry of Economic Affairs and Employment was in December 2014. Thereafter, it was decided that Tekes would have two main objectives: *Dynamic renewal of business and industry, and Finland becoming one of the most attractive innovation environments in the world.* This second objective will be evaluated based upon external evaluations to be carried out in 2016 and 2018.

This impact study is thus the first to evaluate the extent to which Tekes has contributed to the attractiveness of Finland as an innovation environment. As neither the Ministry of Economic Affairs and Employment nor Tekes had explicitly operationalized the attractiveness of an innovation environment, this was the first task of this impact study. The nature of the study has thus been exploratory. We have challenged the original boundary setting of the impact study by not restricting our analysis purely to the domains of Tekes and Team Finland collaborators and by expanding our recommendations towards what we introduce as the establishing of a Lean National Innovation System.

The need for a lean approach was also recognized when the agreement between the Ministry and Tekes, regarding how Tekes will fulfil its objectives vis-à-vis the Ministry, was updated in January 2016. In this agreement, the following activities were listed as measures to reach the objective of Finland becoming one of the most attractive innovation environments in the world:

- Tekes will support the implementation of the spearhead projects initiated by the government through new efficient operational models.
- The roles and responsibilities among the actors of the Finnish national innovation system will be clarified and the collaboration will be intensified.
- Financing to large companies will, to an increasing degree, be allocated to the formation of new ecosystems and the development of the innovation environment.
- Collaboration will be intensified to attract large direct investments to Finland.
- A broad offering development effort will be carried out using service design and lean thinking.
- An efficient (lean) and digital customer service and production platform will be developed.

Subsequently, this impact study adheres to the two main lean principles; elimination of waste and full use of capabilities (Sugimori et al., 1997). The first part of this report develops a new conceptual framework, the Lean National Innovation System, as the "idealized design" for a national innovation system contributing to the attractiveness of the country as an innovation environment.

Comparing the present Finnish innovation system to the "idealized design", the second part of the impact study evaluates how Tekes and the Team Finland partners have been able to contribute to the attractiveness of the Finnish innovation environment. The three previous objectives of Tekes were to (i) contribute to productivity and renewal, (ii) build innovation capabilities, (iii) and promote wellbeing in the society. All these objectives also supported the attractiveness of the innovation environment, but there was no need to explicitly evaluate their joint impact. Contributing to an attractive innovation environment calls for a different evaluation approach, as the attractiveness will be defined

by external stakeholders, and can only be observed indirectly. This also reduces the relevance of an impact model based upon additionality, as the excellence sought for may not be achieved by merely adding the impact of individual factors, but is formed through complex systemic interrelationships among a multitude of factors. This impact study therefore introduces the Excellence Framework as a complimentary tool to the impact model based on additionality. Additionality has proven to be a good way to evaluate the efficiency of innovation support activities, i.e. doing things well. Excellence raises the question of what other things might have been done, i.e. how to do the right things.

The objective of contributing to the attractiveness of Finland as an innovation environment was only added to Tekes's remit at the beginning of 2015. It is therefore too early to make any quantitative assessment of the extent to which Tekes's activities have contributed to the attractiveness of Finland as an innovation environment. However, this impact study has been able to verify that the definition of an attractive innovation environment, and the operationalization of this into the notion of a Lean National Innovation System, receives strong support from previous studies carried out by Tekes and the Ministry of Economic Affairs and Employment.

The meta-analysis done in this impact study, as well as observations from the field, identify that Tekes has been particularly well prepared in strengthening its resource allocation process towards providing more support for entrepreneurship and renewal. Tekes has also succeeded in piloting new initiatives in the formation of new ecosystems, increasing the collaboration between large companies, SMEs and start-ups, universities, and research institutions. However, as Finland can be characterized as a European paradox country, i.e. one with large innovation support efforts but unsatisfactory growth, there is a strong need to look for additional potential to increase the attractiveness of the innovation environment. Here we identify measures related to the demand-side of the innovation environment as the most promising area for improvement. This requires significantly stronger collaboration between Tekes and other governmental actors. Additionally, we foresee that Tekes could take a stronger role in driving change throughout the Finnish innovation system as the systemic efforts needed call for an actor that has the capacity to build the dynamic capabilities needed for the future.

In November 2016, it was announced that the Team Finland activities will be re-organized. This confirms the need for a serious evaluation of the right things to do to increase the attractiveness of Finland as an innovation environment. The recommendation of this impact study is to take a broader view on the potential of the government to support the innovation activities not just through the Team Finland actors, but also by engaging other ministries and governmental agencies, and to also increasingly see innovative procurement as a strategic means in innovation policy. Innovation policies and industrial policies should as well be more strongly integrated. By introducing Strategic Innovation Initiatives, Finland could, in selected competence areas, significantly increase the attractiveness of the innovation environment. Some promising results in this direction can already be identified in the health and well-being sector.

The recommendations presented in the third part of this report can be summarized into three key core activities to be carried out in parallel. These activities will also call for new priorities from the key actors in the Finnish innovation system:

1. Solidifying the governance of the Finnish innovation system, putting the Research and Innovation Council firmly in charge of the stewardship of the transformation of the national innovation system.
2. Ensuring proper process support for the Research and Innovation Council by establishing an Innovation Transformer function hosted in Tekes as the administrative body of the Lean National Innovation System. The Innovation Transformer function is responsible for the continuous strengthening of governmental capabilities and monitoring and supporting Strategic Innovation Initiatives.
3. Increasing the efforts to get Finnish businesses and research institutions inserted in strategic global networks by assuring that Team Finland actors, leading universities, and relevant ministries are aligned with the global objectives of the Finnish innovation and industrial policies. Building such global pipelines calls for collaborative efforts between governmental agencies, researchers, and companies to create the critical mass of knowledge needed to become attractive for relevant global partners.

Based on an intensive effort from a group of experienced professionals over a period of six months, we feel confident that the here presented guidelines could be operationalized into an actionable policy document, becoming the basis for taking the Finnish innovation system to the next level. Using the suggested candidates for Strategic Innovation Initiatives (Social and healthcare systems, Urban transport, Adaptive manufacturing ecosystems, and Waste management and recycling), as pilot cases for how to move forward, we think rapid progress could be achieved. By working closely with the various actors relevant for forming the innovation ecosystems around these topics it would be possible from the outset to test the process of action learning which should characterize the Lean National Innovation System.

Tiivistelmä suomeksi

Tiivistelmä

Tämä vaikuttavuustutkimus on ensimmäinen, jossa arvioidaan, miten Tekes on edesauttanut Suomen houkuttelevuutta innovatiivisena ympäristönä. Olemme haastaneet olemassa olevia rajoja ja laajentaneet suosituksiamme kohti Lean National Innovation System -nimellä kutsumamme järjestelmän vahvistamista.

Lean-lähestymistavan tarve tunnistettiin myös ministeriön ja Tekesin keskinäisessä sopimuksessa liittyen Tekesin tavoitteeseen saavuttaa päämäärä, jossa Suomesta tulee houkutteleva innovaatioympäristö:

- Tuetaan hallituksen kärkihankkeiden tehokasta toimeenpanoa uusilla toimintamalleilla.
- Kehitetään innovaatioympäristöä roolitusta selkeyttämällä ja yhteistyötä tiivistämällä.
- Kohdennetaan suurten yritysten rahoitus entistäkin vahvemmin innovaatioympäristön ja uusien ekosysteemien kehittämiseen.
- Tiivistetään yhteistyötä investointien saamiseksi Suomeen.
- Toteutetaan laaja tarjoamauudistus palvelumuotoilua ja lean-ajattelua hyödyntäen.
- Luodaan tehokas (lean) ja digitaalisoitu asiakaspalvelu- ja tuotantoprosessi.

Raportin ensimmäinen osa kehittää uuden käsitteellisen viitekehyksen, Lean National Innovation Systemin, tarttumalla kahteen leanin pääperiaatteeseen; hukan eliminointi ja kyvykkyyksien tehokas hyväksikäyttö. Viitekehys tunnistaa maan houkuttelevuuden osatekijät innovaatioympäristöksi.

Toinen osa tutkimusta arvioi, miten Tekesin ja Team Finlandin toimijat ovat pystyneet edesauttamaan Suomen innovaatioympäristön houkuttelevuutta. Tämä vaatii erilaisen arviointilähestymistavan ja vähentää perinteisen vaikuttavuuden arviointimallin relevanssia. Tavoiteltua erinomaisuutta ei välttämättä saavuteta vain lisäämällä yksittäisten tekijöiden vaikutusta vaan se muodostuu monimutkaisten, monien tekijöiden systeemisten keskinäisten suhteiden kautta. Tästä johtuen tämä tutkimus tuo esille Menestysviitekehyksen (Excellence Framework) lisätyökaluna vaikuttavuutta arvioidessa.

Tässä tutkimuksessa tehdyn meta-analyysin sekä asiakaskentältä saatujen kommenttien perusteella tunnistetaan, että Tekes on ollut erityisen hyvä allokoimaan resursseja yrittäjyyden ja start-up toiminnan tukemiseen. Tekes on myös onnistunut pilotoimaan uusia aloitteita uusien ekosysteemien avulla. Koska Suomea voidaan kuvailla ”eurooppalaisen paradoksin” -esimerkiksi eli maaksi, joka laajasti tukee innovaatiohankkeita, mutta jonka kasvu on epätyydyttävää, on kuitenkin suuri tarve etsiä uusia mahdollisuuksia innovaatioympäristön houkuttelevuuden lisäämiseksi. Tunnistamme tässä innovaatioympäristön kysyntäpuoleen liittyvät toimenpiteet kaikkein lupaavimmaksi kehitysalueeksi. Tämä vaatii erityisen vahvaa yhteistyötä Tekesin ja valtion muiden toimijoiden välillä. Lisäksi näemme, että Tekes voisi ottaa vahvemman roolin muutoksen ajamisessa läpi suomalaisen innovaatiojärjestelmän, sillä tarvittavat systeemiset toimenpiteet edellyttävät toimijaa, jolla on kyky rakentaa tarvittavat uudet dynaamiset kyvykkyydet.

Tämän raportin suositukset voidaan tiivistää kolmeen keskeiseen rinnakkaiseen aktiviteettiin. Voimme kutsua näitä aktiviteetteja myös suomalaisen innovaatiosysteemin uusiksi prioriteeteiksi.

1. Suomalaisen innovaatiojärjestelmän ohjauksen vahvistaminen asettamalla Tutkimus- ja innovaationeuvosto vastuuseen kansallisen innovaatiojärjestelmän muutoksen suunnasta.
2. Vahvan prosessituen varmistaminen Tutkimus- ja innovaationeuvostolle perustamalla Tekesiin Muutosjohtajuustoiminto. Muutosjohtajana Tekes on vastuussa ohjauskyvykkyyksien ja dynaamisten kyvykkyyksien jatkuvasta vahvistamisesta sekä strategisten innovaatioaloitteiden seurannasta ja tukemisesta.
3. Suomalaisen liike-elämän ja tutkimuslaitosten aktiivisempi osallistuminen strategisiin globaaleihin verkostoihin innovaatiojärjestelmän ja Team Finlandin toimijoiden tukemina. Tällaisten kansainvälisten kehityskanavien rakentaminen vaatii valtion virastojen, tutkijoiden ja yritysten yhteisiä ponnisteluja, jotta pystytään luomaan tarvittavat osaamiskeskittymät ja kehitysmahdollisuudet kansainvälisten kumppaneiden houkuttelemiseksi.

Mitkä ovat houkuttelevan innovaatioympäristön päätekijät?

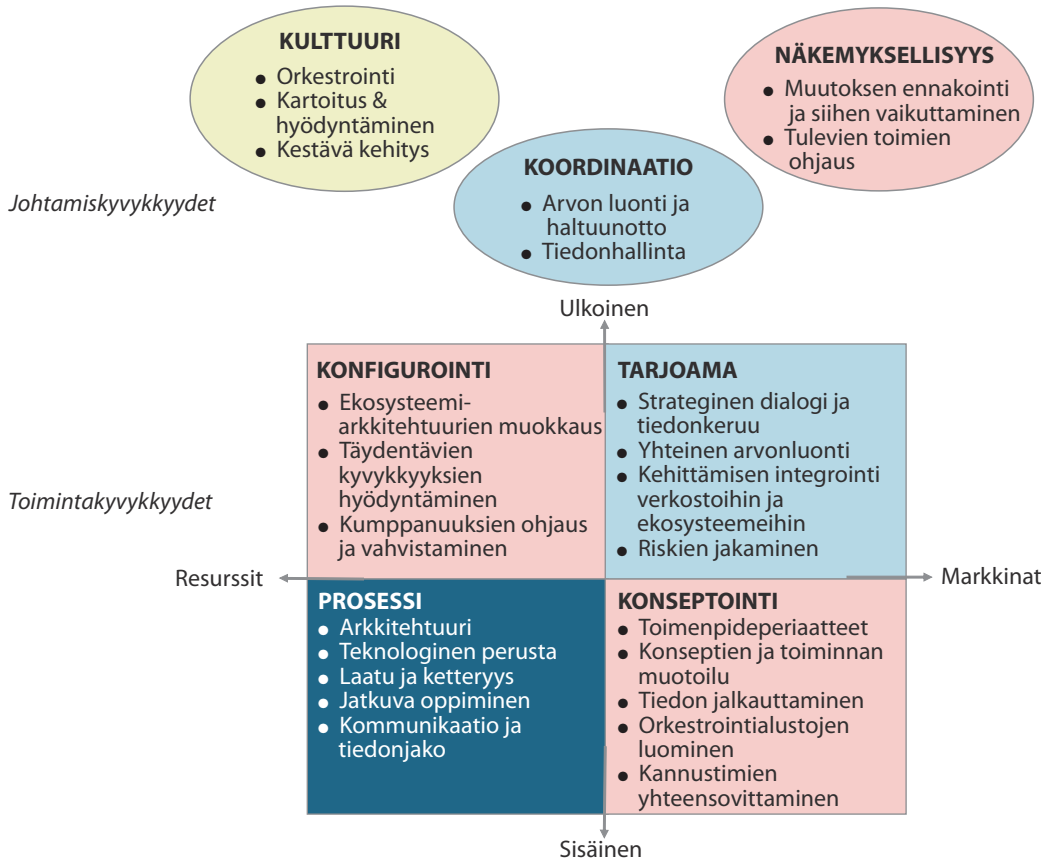
Houkutteleva innovaatioympäristö vaatii aktiivisen, kansainvälisen vuorovaikutuksen. Erinomaisuuteen pyrkiminen edellyttää huippuyliopistojen, tutkijoiden ja yritysten globaalin verkoston. Innovaatioympäristön resurssit on hankittava kansainvälisesti. Tämä vaatii keittynyttä ohjauskyvykkyyttä. Toimimalla "julkisena yrittäjänä" julkisen sektorin toimijan rooli voi olla erittäin tärkeä, kun rahoitetaan tarvittavaa tutkimusta sekä levitetään uutta tietoa pienten ja keskisuurten yritysten aseman vakiinnuttamiseksi kasvavissa ekosysteemeissä.

Pitkäaikaisen liiketoimintaekosysteemin kestävyys riippuu siitä, miten vahvoja sen dynaamiset kyvykkyydet ovat. Dynaamiset kyvykkyydet ovat kyky (1) vaistota ja hahmottaa mahdollisuuksia ja uhkia, (2) tarttua mahdollisuuksiin ja (3) pitää yllä kilpailukykyä parantamalla, yhdistämällä, suojelemalla ja tarvittaessa määrittelemällä uudelleen liiketoiminnan aineettomat ja aineelliset voimavarat. Markkinoiden luominen, ja yhdessä luominen edustaa huippukyvykkyyttä, kaikkien dynaamisten kyvykkyyksien äiti. Ohjauskyvykkyys on kyky ennakoida ja vaikuttaa muutokseen, ohjata tulevia toimia (näkemyksellisyys), tehdä tietoisia ja älykkäitä päätöksiä toimintatavoista, luoda ohjelmia toimintatapojen jalkauttamiseksi (konseptointi), houkutella resursseja, hallita resursseja ja arvioida käynnissä olevia aktiviteetteja (konfigurointi).

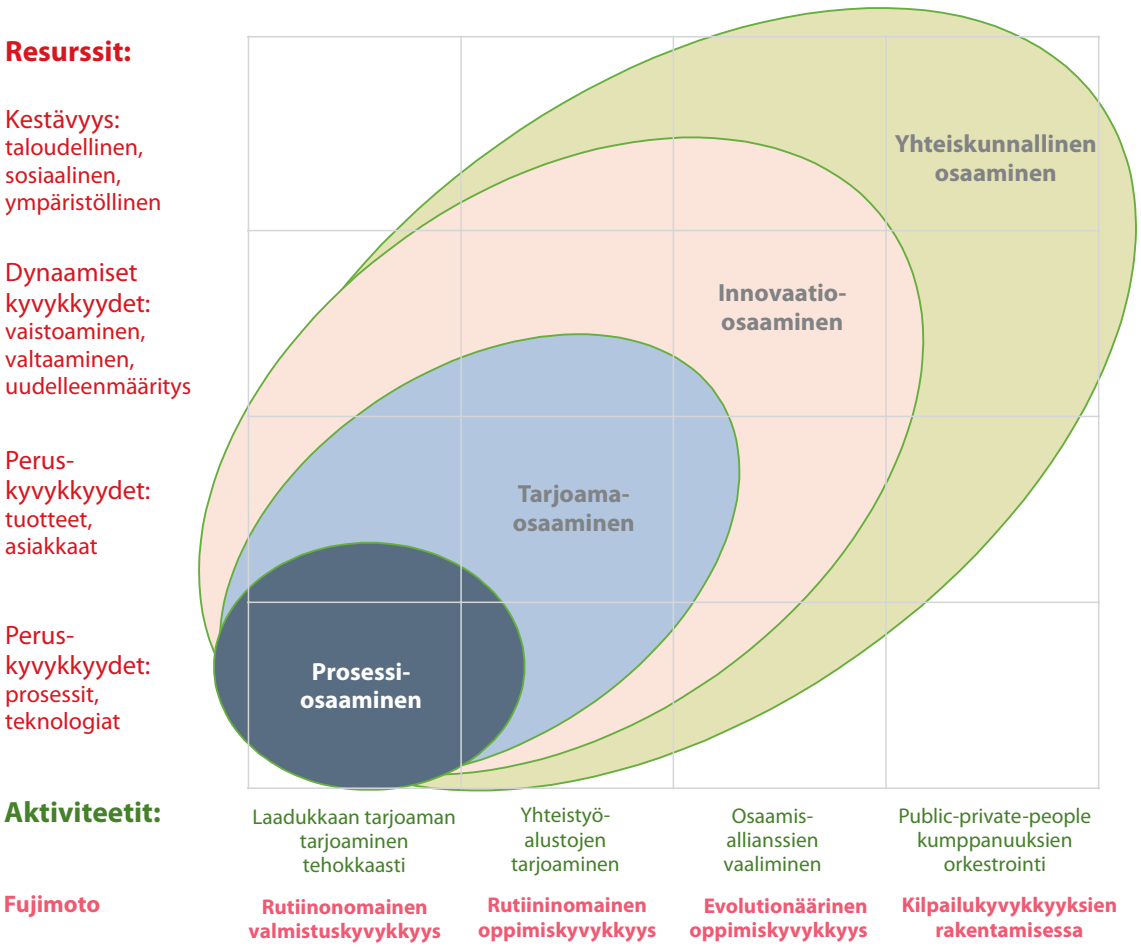
Kyvykkyyksien kehittämisen priorisointi vaatii niiden luokittelun. Jaamme kyvykkyydet johtamis- ja toimintakyvykkyyksiin. Toimintakyvykkyyksissä luokittelu sisältää sen, liittyykö kyvykkyys ulkoiseen vai sisäiseen näkökulmaan ja onko ne suunnattu kohti arvoa tuottavien toimintojen resursseja vai markkinaulottuvuutta. Kuvassa 1 on esitetty kyvykkyyskartta (dynaamiset kyvykkyydet on merkitty punaisella ja peruskyvykkyydet sinisellä).

Tavassa, miten innovaatiopolitiikka on kehittynyt länsimaissa, on havaittavissa suuntaus prosessitehokkuudesta kohti kestävää kehitystä ja isojen yhteiskunnallisten kysymysten ratkomista. On asteittaista siirtymistä prosessifokuksesta kohti monimuotoisempaa huippuosaamisen ymmärtämistä, joka sisältää myös tarjoamaosaamisen, innovaatio-osaamisen ja yhteiskunnallisen osaamisen. Tähän perusten olemme kehittäneet Menestysviitekehyksen. Se on työkalu, jolla voidaan tunnistaa tärkeät asiat houkuttelevassa innovaatioympäristössä. Menestysviitekehys on havainnollistettu kuvassa 2:

Kuva 1. Kyvykkyyskartta (Capability Map, perustuen Synocuksen tutkimukseen).



Kuva 2. Osaamisen viitekehys (Excellence Framework, perustuen Synocuksen tutkimukseen).



Tämänhetkinen trendi suosii tavoite- tai missiolähtöistä innovaatiotoimintaa, jossa julkinen sektori toimii sekä osallistujana että innovaatioprosessin rahoittajana. Tämä saavutetaan valtion hajautetulla toiminnalla, jolloin suositaan paikallista toimeenpanoa mutta varmistetaan keskitettyä ohjausta. Tämä vaatii julkisen sektorin viranomaisilta monen roolin ottamista yrittäjyyden tukemisessa.

Houkutteleva innovaatioympäristö (Attractive Innovation Environment, AIE) on ympäristö, jossa on houkuttelevaa innovoida eli ympäristö (alue, maa jne.), jolla on korkeatasoista innovaatiotoimintaa. Tämä määritelmä on mahdollista toteuttaa empiirisesti edellyttäen, että innovaatiotoimintaa voi mitata. Sillä on myös se etu, että voimme käyttää vakiintunutta innovaatioteoriaa ja -tutkimusta keskustellaksemme, miten sellainen ympäristö toimii ja miten eri toimintalinjaukset saattaisivat vaikuttaa siihen.

Poliitikot eivät kuitenkaan normaalisti välitä innovaatioista niiden itsensä vuoksi vaan sosiaalisten ja etenkin taloudellisten hyötyjen vuoksi, joita niillä yleisesti ottaen oletetaan olevan. Tästä johtuen AIE:n määritelmän tulee sisältää tämä ulottuvuus, jotta se pystyy toimimaan poliittisen ohjauksen työkaluna. AIE on siten ympäristö, jossa korkea innovaatiotoiminta saa aikaiseksi sosiaalista ja taloudellista hyötyä.

Se, että korkea innovaatiotoiminta ja hyvät taloudelliset tulokset kulkevat käsi kädessä, voi olla intuitiivisesti houkuttelevaa, mutta käytännössä asia ei aina ole niin. Kun kaivaudumme vähän syvemmälle tähän suhteeseen, kuva 3 näyttää innovaatiotoiminnan (korkea/matala) verrattuna taloudelliseen suorituskykyyn (epätyydyttävä/hyvä).

Kuvan 3 oikeassa yläkulmassa korkea innovaatiotoiminta yhdistyy positiiviseen taloudelliseen dynamiikkaan, toisin sanoen se on houkutteleva innovaatioympäristö (AIE), kuten yllä on määritelty. Tähän tietysti käytännössä pyritään. Monet, elleivät jopa useimmat, globaalissa talouden piirissä olevat maat tai alueet eivät kuitenkaan ole näin onnekkaita. Todellisuudessa suuressa osaa maailmaa asiat ovat päinvastoin, alhainen innovaatiotoiminta ja epätyydyttävä taloudellinen suorituskyky, toisin sanoen vasen alakulma.

Kuva 3. Houkutteleva innovaatioympäristö ja "eurooppalainen paradoksi".

	Taloudellinen suorituskyky: Epätyydyttävä	Taloudellinen suorituskyky: Hyvä (dynaaminen)
Korkea innovaatiotoiminta	"Eurooppalainen paradoksi"	Houkuttelevat innovaatioympäristöt (AIE)
Alhainen innovaatiotoiminta	Suuri osa kehittyvistä maista, monet Euroopan alueet	Globaaleihin arvoketjuihin integroituneet matalapalkka-alueet

Seuraavassa esittelemme muutamia keskeisiä näkemyksiä innovaatioteoriasta ja tutkimuksista, jotka ovat innovaatiopolitiikan suunnittelun ja toteutuksen kannalta tärkeitä (erityisesti AIE:n tavoitteiden toteuttamiseksi):

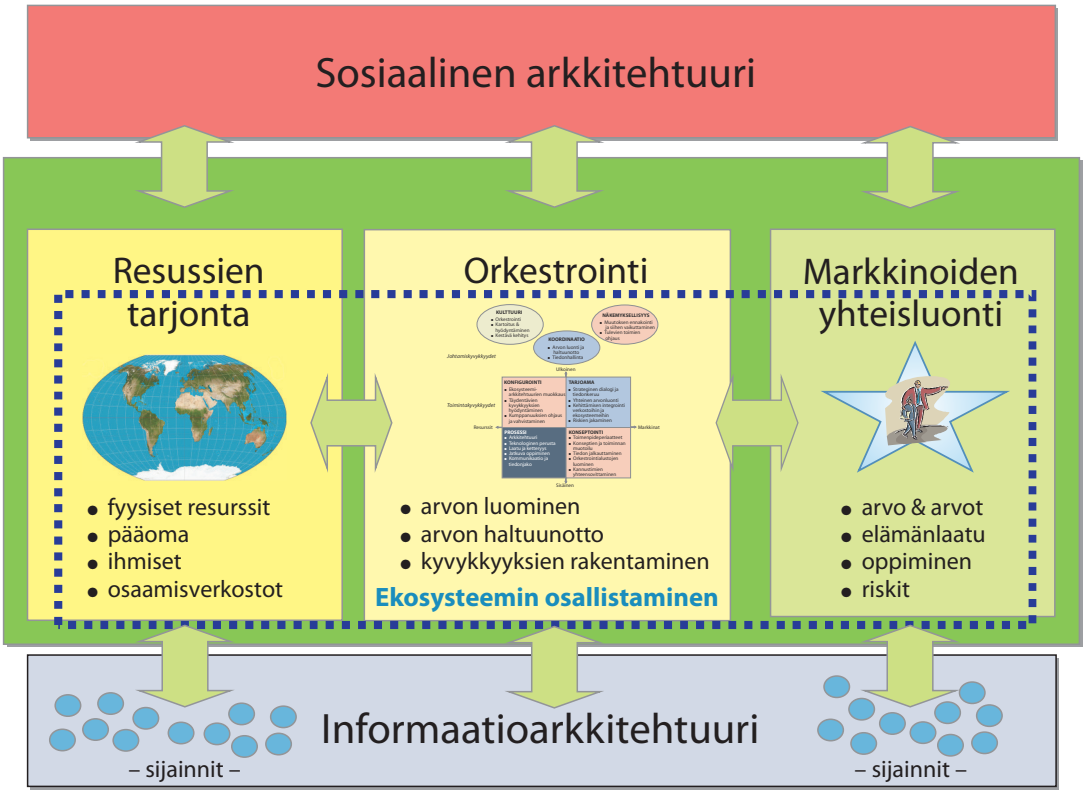
- AIE:t ovat avoimia järjestelmiä. Paljon, ellei suurin osa oleellisesta tiedosta on peräisin maan tai alueen rajojen ulkopuolelta. Tällaisen ulkopuolisen tiedon hyödyntäminen ei ole kuitenkaan vähäpätöinen asia. "Avoimuus" ei korvaa paikallisen kyvykkyyden rakentamista.
- AIE:t – tai kansalliset ja alueelliset innovaatiojärjestelmät – voivat olla "suljettuja" ei pelkästään ulkomaisilta vaan myös kotimaisilta ja paikallisilta lahjakkuuksilta, kyvykkyyksiltä ja resursseilta. Kyky mobilisoida laaja joukko eri taustaisia paikallisia toimijoita innovaatioprosessiin voi olla lopputuloksen kannalta kriittinen.
- Kansalliset innovaatiojärjestelmät kehittyvät pitkällä aikavälillä maan taloudellisten ja poliittisten järjestelmien välisen vuorovaikutuksen kautta, ja vaikka ne suorittavat monia samoja toimintoja, ne voivat kuitenkin olla varsin erilaisia rakenteeltaan ja toimintatavoiltaan. Poliittisten käytäntöjen mekaaninen siirto maiden välillä voi helposti saada aikaan enemmän haittaa kuin hyötyä.
- Innovaation onnistuminen riippuu useasta toistaan täydentävästä tekijästä. Tarvitaan laajaa ja kokonaisvaltaista näkemystä, joka mahdollistaa mahdollisten pullonkaulojen tai "tukkeiden" tunnistamisen.
- Se, että poliittiset välineet ovat vuorovaikutuksessa merkitsee myös sitä, että yksittäisten poliittisten välineiden arviointi ei ole luotettavaa ja se on korvattava/täydennettävä järjestelmätason arvioinneilla.
- Innovaatiolle on ominaista tietty epävarmuus, mikä on merkittävä este varsinkin mullistavien innovaatioiden kohdalla. Kysyntään perustuvat poliittiset linjaukset, kuten julkiset hankinnat tai myös erilaiset normit ja määräykset, voivat vähentää epävarmuutta, tarjota mahdollisuuksia ja nopeuttaa innovaatioiden liikkeellelähtöä. Mahdollisuudet innovaatioihin voivat myös syntyä poliittisista tavoitteista, joita poliitikot asettavat yhteiskunnan kehittämiseksi, kuten esimerkiksi siirtyminen kestävään talouteen.
- Mahdollisuuksia voi myös syntyä teknologisten ja ICT-mullistusten sekä "greentech"-vallankumouksen kautta eikä vähiten näiden yhdistelmän ansiosta, jossa Suomella voi olla erinomaiset edellytykset.
- Tehokas innovaatiopolitiikka edellyttää mahdollisuuksien kartoituksen, ymmärrys innovaation vaikutuksista julkiseen politiikkaan ja tiiviin poliittisen yhteistyön monien eri alojen ja hallinnon tasojen kanssa. Tämä on hyvin vaativaa ja herättää kysymyksen siitä, miten innovaatiovirastojen ja hallituksen kyvykkyydet voidaan yleisemmin nostaa vastaamaan vaatimuksia. Mitä tulee poliittisten linjausten koordinointiin, Suomea pidetään edelläkävijänä ja sen kokemuksia tulisi jakaa laajemmin.

Houkuttelevassa innovaatioympäristössä on kolme keskeistä tekijää: resurssitarjonta, markkinoiden yhdessä luominen, ja orkestroinnin ja kyvykkyyksien jatkuva kehittäminen (kuva 4). Sekä kansallisen hallituksen että alueellisten innovaatiotoimijoiden on nämä vahvistettava. Kun päätetään, miten innovaatioita tuetaan, kriittiset kysymykset ovat seuraavat:

- Mitä toimialoja tulisi tukea?
- Mitä tukien yhdistelmää (resurssitarjonta, markkinoiden yhdessä luominen ja orkestroinnin ja kyvykkyyksien rakentaminen) tulisi soveltaa valituilla toimialoilla?
- Miten tuen toteuttamista tulisi seurata ja säätää perustuen todellisiin tuloksiin?

On tarvetta keskittyä rakentamaan organisatorisia kyvykkyyksiä, jotka auttavat luomaan valmiudet jatkuvalle innovoinnille, sillä uudet lainalaisuudet edellyttävät sekä tehokkuuden että innovaatioiden samanaikaista lisäämistä. Kuvassa 4 on käytetty orkestroinnin viitekehystä kuvaamaan eri elementtien yhdistelmää, joka muodostaa houkuttelevan innovaatioympäristön.

Kuva 4. Orkestroinnin viitekehys (perustuen Synocuksen tutkimustyöhön).



Case-tutkimukset

Yksi innovatiivisuuden este Suomessa on viime aikoina ollut yhteiskunnan kielteinen asenne ja pessimismi. Tähän julkisella sektorilla itsellään voi olla mahdollisuus vaikuttaa. Maassa on tarvetta juurruttaa vahvempaa uskoa tulevaisuuteen; tämä edellyttää laajempaa jaettua visiota, joka ohjaa pyrkimyksiä edistyä ja menestyä globaalissa kilpailussa. Jos voimme tarjota vision tulevaisuudesta ja luottamuksesta Suomen kapasiteettiin tulla vielä kerran kansainväliseksi johtavaksi toimijaksi tietyillä sektoreilla, meillä on hyvät mahdollisuudet vakiinnuttaa uudelleen Suomen asema innovaatiojohtajana. Tämä näkemys on tullut selkeästi niissä haastattelussa mitä tätä tutkimusta tehdessä sekä niissä yritysanalyyseissä mitä suoritettiin. Tehtiin yhteensä seitsemän yritysanalyysia. Kolme erityyppistä yritystä analysoitiin.

Ensimmäistä ryhmää voidaan kutsua nimellä t&k-keskukset. Tätä kategoriaa edustavat Zalando, Intel ja Huawei. Tyypillistä t&k-keskuksille on, että emoyhtiö on arvioinut, mihin t&k-toimintaa sijoitetaan, ja perustuen syvällisiin arviointeihin se on valinnut Suomen t&k-toiminnan sijaintipaikaksi.

Toista ryhmää voimme kutsua Integroiduiksi yritysostoiksi. GE Healthcare, Vallox ja Mayer Turku kuuluvat tähän ryhmään. Näillä yrityksillä on Suomessa pitkä historia. Jossain vaiheessa ulkomainen yritys on ostanut tämän suomalaisen yrityksen vahvistaakseen asemaansa Suomessa ja kansainvälisesti.

Viimeistä luokkaa kutsumme Suomalaissyntyisiksi globaaleiksi, jota edustaa Aava Mobile. Se perustettiin vuonna 2009 tavoitteenaan palvella maailmanmarkkinoita perustuen pitkän kansainvälisen kokemuksen globaaleissa yrityksissä omaavien perustajien visioon.

Jokaisella yrityskategorialla on hieman erilaiset motiivit valita Suomi innovaatiomaakseen. Yritysten t&k-toiminnan kannalta näemme, että alueen tarjoamat resurssit edustavat merkittävintä houkuttelevuutta, jota seuraavat kommentit kuvaavat:

- Houkuttelevuus tarkoittaa, että koko ekosysteemin tulee olla valmiina sisältäen osaavan henkilöstön, luovan kulttuurin, laajemman startup-ekosysteemin sekä tukea antavan julkisen sektorin. Tässä on vielä parantamisen varaa, jotta Suomi erottuu kovassa kilpailussa.

- Huhtikuussa 2011 ilmoitettiin, että Intel avaisi Suomeen t&k-yksikön, koska Nokia vähensi väkeä. Alkuperäisen ilmoituksen mukaan tultaisiin palkkaamaan noin 200 henkeä. Samanaikaisesti Intelin ilmoituksen kanssa myös Google, Skype ja Samsung olivat avoimesti kertoneet, että myös ne halusivat hyödyntää Suomen teknistä osaamista, joka etsi uusia työpaikkoja Nokian leikkausten johdosta.
- Huawein tutkimuskeskus Helsingissä tekee tutkimusta matkapuhelinteknologiasta. Suuri osa sen tutkimuksesta Suomesta keskittyy tällä hetkellä 5G-radioteknologiaan ja tietoturvaan. Muut t&k-toimet sisältävät mobiililaitteiden grafiikan, mobiiliselaimet ja muun verkkoteknologian, kulutustuotteiden käyttöliittymien suunnittelun. Huawei osallistuu myös Linaroon.

Voimme nähdä, että erikoisosaaminen erityisesti mobiili- ja viestintäteknologiassa on ollut tärkein alkuperäinen syy perustaa t&k-keskus Suomeen. Koska yksikkö on vakiintunut, se on myös alkanut osoittaa lisääntynyttä kiinnostusta mahdollisuuteen luoda markkinoita yhdessä.

- Pyrkiessään kohti uusia suuntia, olemme myös yrittäneet rakentaa uusia ekosysteemejä, esim. liikkuvien koneiden tuottajien kanssa Tampereen alueella. Tässä on ollut varsin haastavaa saada yritykset aidosti sitoutumaan. Suomalaisille yrityksille tuntuu olevan vaikeaa kuvitella todellista win-win-win-mahdollisuutta. Yritykset ovat sen sijaan enemmän puolustuskannalla ja pelkäävät, että heidän osaamisensa joutuu toisen yrityksen käsiin ilman, että he itse saavat siitä mitään hyötyä. Tämä herättää kysymyksen, miten tällaisten ekosysteemien tulisi käynnistää ja orkestroida.

Niiden yritysten kohdalla, joilla ovat Suomi-lähtöisiä ulkomaan omistuksessa olevia teollisia toimijoita, näemme paljon vahvemman kiinnostuksen innovaatioympäristön markkinoiden luomiseen.

- GE Healtcare Finland odottaa, että HUS yhteistyössä Suomen valtion kanssa pystyy tarjoamaan testiympäristön GE:lle Suomessa. Tämä parantaisi entisestään GE Healthcare Finlandin mahdollisuuksia kasvattaa rooliaan konsernin sisällä ja lisäisi myös Suomen kiinnostavuutta muiden kansainvälisten teknologiayritysten silmissä. Tämän pitäisi näkyä myös julkisissa hankintasopimuksissa, jotta aidosti uusia terveysteknologioita voidaan ostaa julkisten hankintojen kautta.
- Meyer Turun tämänhetkinen vahva kysyntä perustuu kahteen tärkeään tapahtumaan ennen Turun telakan liittymistä Meyeriin. Ensinnäkin vahvan toimittajaverkoston kehittyminen Suomen länsirannikolla, mikä on luonut Turun telakalle verkostotason osaamista, jota voidaan tehokkaasti käyttää vaativissa asiakastarpeissa. Toiseksi Suomen valtion tuki uusien teknologioiden kehittämisessä, esim. ensimmäisen LNG-laivan, Viking Gracen kohdalla, josta tuli Turun telakalle arvokas referenssi.
- Suomen vaativat ilmasto-olosuhteet (vaativammat kuin Keski-Euroopassa) ovat arvokas tausta, jonka kautta on kehitetty lämmön talteenotto-osaamista ei vain Valloxissa vaan myös muissa johtavissa yrityksissä kuten Enervent, Swegon ja Iloxair (Fläkt Woods). Perussuunnitteluosaaminen on myös korkeatasoista Suomessa.

Muita haastateltujen yritysedustajien korostamia näkökohtia ovat kansainvälinen verkottuminen ja maailmanlaajuisten yhteistyökanavien perustaminen.

- Suomi voisi myös tukea maailmanlaajuisten yhteistyökanavien vahvistamista, esimerkiksi yhteistyö terveysteknologiassa Suomen ja Kiinan välillä kiinnostaa.
- Vallox harkitsee parhaillaan osaamiskeskuksen kehittämistä, joka myös hyödyntäisi kansainvälistä osaamista.
- Turun telakka on Suomen merenkulkualan ydin. Nyt osana Meyer Groupia painopiste on tehdä tuotantoprosessista entistä tehokkaampi. Laaja investointiohjelma on jo hyväksytty Turun telakan tehokkuuden parantamiseksi ja tuotantoaikojen lyhentämiseksi, ja lisää on valmisteilla.

Aava Mobile case osoittaa, miten resurssitarjonnan kasautuminen ja suhteiden luominen yrityksiin, joissa perustajat aiemmin työskentelivät, muodostivat yhdessä Tekesin rahoituksen kanssa perustan yrityksen nopealle kasvulle. Tärkeää on tässä ajatus siitä, että suhteet johtaviin kansainvälisiin yrityksiin, mikä oli olennaista Aava Mobilen orkestroimalle ekosysteemin muodostumiselle, luotiin suoraan kansainvälisten yritysten pääkonttoreihin aluksi ilman paikallisten tytäryhtiöiden osallistumista. Tämä korostaa maailmanlaajuisen orkestroinnin tärkeyttä. Innovaatioympäristölle on valtava haaste pystyä tukemaan tällaista toimintaa. Tämä tulee kuitenkin myös olemaan edellytys uusien maailmanlaajuisten markkinoiden ja ekosysteemien muodostumiselle tavalla, jonka Aava Mobile on pystynyt saavuttamaan mobiileilla myyntikanava-alustoilla (MPOS). Aava Mobile nimenomaan ilmoittaa, että se suosii vahvempaa tukea yhdistäessään yrityksen kansainvälisiin mahdollisuuksiin ennemmin kuin kotimaiseen yhteistyöhön.

Osa II Suomalaisen innovaatio-ympäristön arviointi

Tämän tutkimuksen tavoitteena on tuottaa yhdistetty, tulevaisuuteen katsova (ennakoiva) arviointianalyysi siitä, miten Tekesin ja Team Finlandin yhteistyökumppanit ovat onnistuneet saavuttamaan tavoitteitaan, jotka liittyvät pyrkimyksiin edesauttaa Suomea tulemaan houkuttelevaksi innovaatioympäristöksi. Voidaksemme tehdä tämän analyysin ja sen myöhemmät suositukset, tunnistimme ensimmäisessä tutkimusosiossa ne innovaatioympäristön tekijät, jotka ovat välttämättömiä Suomen talouden ja yhteiskunnan muuttumiseksi houkuttelevaksi ylimmällä kansainvälisellä tasolla. Tämä johti ihannemallin kuvaamiseen. Kutsumme tämän mallin nimellä Lean National Innovation System. Tämä malli tarjoaa meille perustan arvioida, missä määrin suomalaisella innovaatioympäristöllä on tällaisen innovaatioympäristön ominaisuuksia.

Arvioinnin päätavoitteena on tuottaa helposti ymmärrettävä vaikutustutkimus ja keskustelua herättäviä tuloksia tulevaisuuden toimia varten. Suositusten tulisi vastata seuraaviin kysymyksiin:

- Miten suomalaista innovaatioympäristöä voidaan yleisesti ottaen parantaa?
- Miten Tekes voi parantaa vaikutustaan suomalaiseen innovaatioympäristöön?
- Miten muut Team Finlandin toimijat (erityisesti Finpro ja Finncera) voivat parantaa vaikutustaan suomalaiseen innovaatioympäristöön?

Tämän raportin toisen osan rooli on arvioida suomalaisen innovaatioympäristön nykytila ja miten hyvin Tekesin ja Team Finlandin toimijat ovat vaikuttaneet tämän ympäristön houkuttelevuuteen. Tämä tehdään vertailemalla missä määrin tunnistamamme tavoitemalli, Lean National Innovation System, on jo olemassa tai on tunnistettu mahdolliseksi suomalaisen innovaatiojärjestelmän tulevaisuuden ominaisuudeksi.

Aloitamme esittämällä kuusi ehdotusta Suomen innovaatioympäristön perustaksi. Arvioidessamme tämän perustan olemassaoloa ja luonnetta käytämme kolmea eri lähestymistapaa tarjotaksemme näkökulmia joka kohdasta. Ensimmäinen lähestymistapa on meta-analyysi. Olemme tehneet perusteellisen analyysin Tekesin, työ- ja elinkeinoministeriön ja Sitran seitsemästätoista viimeaikaisesta arviointraportista tai vaikuttavuustutkimuksesta. Meta-analyysissa käytetään lainauksia näistä raporteista ymmärryksen syventämiseksi jokaisen esitetyn ehdotuksen merkityksestä ja luonteesta. Toinen lähestymistapa täydentää kenttähavainnoin eri lähteitä käyttämällä meta-analyysin tuloksia saadakseen lisänäkökulmia esitettyihin kysymyksiin. Kolmas lähestymistapa tarjoaa kirjoittajien päätelmät meta-analyysin tuloksista ja muista havainnoista, joita on paikoittain täydennetty lainauksilla Suomen lehdistöstä. Synteesi käsittelee myös oleellisia kysymyksiä, jotka liittyvät siihen, miten Tekesin ja Team Finlandin kumppanit ovat onnistuneet tähän mennessä saavuttamaan Tekesin tavoitteet edistää Suomen pyrkimyksiä tulla houkuttelevaksi innovaatioympäristöksi. Näin pyrimme varmistamaan, että analyysimme ja arviointimme on mahdollisimman objektiivinen.

Lean National Innovation System -malliin perusteella teemme seuraavat kuusi ehdotusta:

Ehdotus 1. ***Suomi on esimerkki eurooppalaisesta paradoksista; tämä edellyttää kansallisen innovaatiojärjestelmän uudelleenarviointia.***

Ehdotus 2. ***Kansallisten innovaatioympäristöjen nopeasti muuttuva ympäristö edellyttää valtion vahvempaa ohjausta.***

Ehdotus 3. ***Valtion hallinnassa olevien resurssien paremman allokoinnin mahdollistamiseksi on tarpeen selkeästi määritellä kansallisen innovaatiopolitiikan prioriteetit. Se vaatii tukea näkemystä omaavalta toimijalta, joka avustaa valtion ylintä johtoa innovaatiopolitiikan ohjaamisessa.***

Ehdotus 4. ***Innovaatiopolitiikan täytäntöönpano tulee luoda uusia markkinoita ja ekosysteemejä. Tämä edellyttää kokonaisvaltaista toimintaa, jossa strategiset innovaatioaloitteet muodostavat sisällöllisen ytimen. Niiden avulla varmistetaan, että luodusta arvosta merkittävä osa voidaan pitää Suomessa, ja että arvonluonnin lisäksi innovaatiotoiminta myös kasvattaa osaamisvarantoja ja vahvistaa innovaatiojärjestelmän dynaamisia kyvykkyyksiä.***

Ehdotus 5. ***Kansallisen innovaatiojärjestelmän vaalimisen tulee hoitamaan toimijat, jotka vahvistavat ohjausta ja tukevat valtion johtoa jatkuvalla tiedolla (i) järjestelmän tilasta, (ii) ympäristössä tapahtuvista muutoksista ja (iii) missä määrin on tarpeellista säätää järjestelmää sopeutumaan sekä järjestelmän sisäisiin että ulkoisen ympäristön muutoksiin.***

Ehdotus 6. ***Uuden kansallisen innovaatiojärjestelmän ohjaus edellyttää uusia työkaluja ja kannustimia, jotka tulisi ottaa asteittain käyttöön varmistaen tehokkaan siirtymisen vanhasta uuteen.***

Arvioinnin yhteenveto

Tässä suoritetun arvioinnin kaksi tärkeintä päätelmää ovat seuraavat:

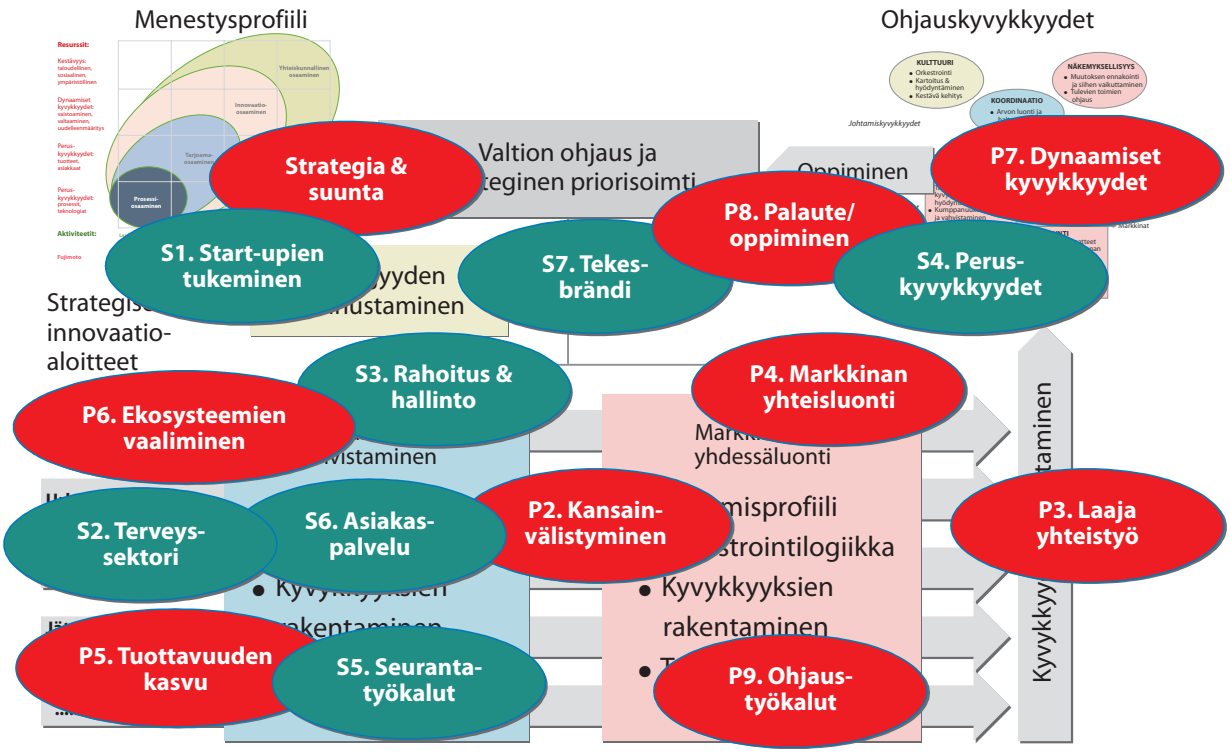
- **On tarpeellista keskittyä siihen, mikä seuraavan sukupolven kansallisen innovaatiojärjestelmän tulisi olla.**
- **Perussyy nykyisille vaikeuksille on alikehittyneet ohjauskyvykkyydet.**

Arviointi on osoittanut, että ehdotettu Lean National Innovation System -viitekehys sopii hyvin kuvaamaan Suomen innovaatioympäristöä. Käytämme tätä viitekehystä antaaksemme yleiskuvan siitä, miten Tekes tukee Suomen houkuttelevuutta innovaatioympäristönä. Kuvassa 5 Tekesin vahvuudet (V) on merkitty vihreillä soikioilla, kun taas mahdollisuudet (M) vahvemmin hyödyntää Tekesin roolia kansallisessa Suomen innovaatiojärjestelmässä on merkitty kuvaan punaisin soikioin.

Kuten näemme kuvasta 5, Tekesin vahvuudet ovat kuvan vasemmalla puolella eli liittyvät resurssitarjontaan, kun taas pääosa mahdollisuuksista on oikealla eli kysyntäpuolella. Näemme myös, että sisältä ulos -näkökulma on vahvuus, kun tarjotaan asiakaspalvelua, luodaan tarvittavia hallinnollisia ja valvontaprosesseja ja kehitetään peruskyvykkyyksiä. Tärkeimmät mahdollisuudet löytyvät siinä, että Tekes ottaa entistä voimakkaamman roolin osoittaakseen Suomen suunnan nykyisessä, vaikeassa tilanteessa. Painopiste ohjelmiin ja rahoitukseen ei yksinomaan riitä, vaan tarvitaan voimakkaampia toimenpiteitä eri osapuolten yhteistyön edistämisessä ja vahvojen uusien ekosysteemien muodostamisessa. Positiivinen poikkeus tähän on viimeaikaiset ponnistelut terveyssektorilla.

Tekesillä on kuitenkin vahva brändi ja erinomaiset suhteet Suomen liike-elämään. Näkyvin uusi menestystarina on pelialalla, mutta laajemmin katsottuna Tekes on viime aikoina hyvin määrätietoisesti uudelleenallokoinut resursseja startup-sektorille. Kuten tässä raportissa on osoitettu, keskittymällä rahoitukseen ei kuitenkaan tänä päivänä riitä houkuttelevan innovaatioympäristön aikaansaamiseksi. Menestyvien ekosysteemien perustaminen ja tuottavuutta edistävien verkostojen rakentaminen ovat olennaisia osia houkuttelevassa innovaatioympäristössä. Tämä edellyttää nykyistä systeemisempää panostusta suomalaiseen innovaatiojärjestelmään. Keskeinen vaatimus tälle tulee olemaan kilpailukykykyiset dynaamiset kyvykkyydet. Seuraavassa osiossa annamme suosituksia siitä, miten tällainen kansallinen innovaatiojärjestelmä voitaisiin perustaa.

Kuva 5. Arvioinnin yhteenveto.



Osa III Suositukset

Käytämme käsitettä suunnannäyttäminen osoittamaan vastuullista johtamista, joka perustuu jatkuvaan pyrkimykseen parantaa maan kilpailukykyä kaikilla menestymisen tasoilla: prosessiosaaminen, tarjoamaosaaminen, innovaatio-osaaminen ja yhteiskunnallinen osaaminen. Tavoitteena on kehittää Suomea innovaatioympäristön edelläkävijäksi yhteiskunnallisten rakenteiden osalta.

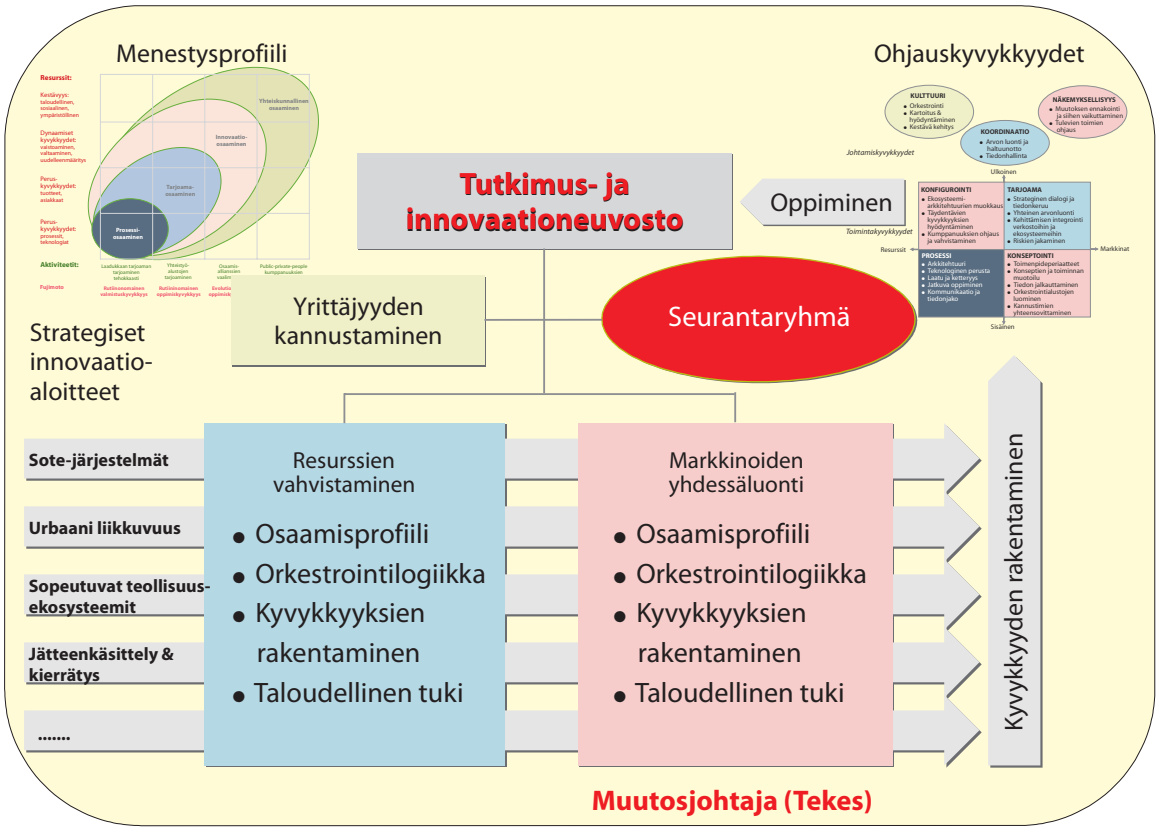
Lean National Innovation System (kuva 6) vaatii näkyvää suunnannäyttämistä valtion johdon taholta. Tämän suunnannäyttämisen tulisi perustua jatkuvalle vuoropuhelulle eri sidosryhmien kanssa ja avoimelle suhtautumiselle uusiin oivalluksiin, jotka kumpuavat jatkuvasta ympäristön muutoksesta. Lisäksi se uudistaa jatkuvasti itseään perustuen meneillään olevaan oppimiseen eri toiminnoissa.

Suomen innovaatiopolitiikkaa on perinteisesti ohjattu vahvasti ylhäältä. SHOK-ohjelman alkuperäinen tavoite perustui myös näihin periaatteisiin. SHOK:n hallintamalli oli kuitenkin puutteellinen, sillä valtio luopui valvontatehtävästään. Väitämmekin, että vahva suunnannäyttäminen on ensimmäinen edellytys Suomelle palauttaa asemaansa innovaatiojärjestelmien esikuvana.

Kun puhumme suunnannäyttämisestä, puhumme johtajuudesta ja sitoutumisesta. Viime aikoina Suomen ajatukset ovat olleet hallinnoimisessa ja organisaatioissa. Siksi suosittelemme, että niin pitkälle kuin mahdollista käytetään jo olemassa olevia organisatorisia viitekehyksiä ja tarjotaan nykyisille organisaatioille uusia toimeksiantoja, selkeämmin määriteltyjä rooleja ja vastuita. Tämä prosessi tulisi aloittaa ylhäältä. Ehdotammekin, että pääministerin sekä Tutkimus- ja innovaationeuvoston tulisi ottaa suomalaisen innovaatiojärjestelmän suunnannäyttäjän rooli. Suunnannäyttämisen suositukset ovat seuraavat:

1. **Suomen hallitus sekä Tiede- ja innovaationeuvosto (TIN) tehostavat pyrkimyksiään ohjata innovaatioita ja teollisuuspolitiikkaa Suomessa priorisoimalla innovaatiotavoitteita resurssien allokoinnilla yrittäjyyden kannustamiseksi, resurssien vahvistamisella ja uusien markkinoiden luomisella. TIN valvoo ja ohjaa valtion innovaatiotoimintaa seuraavin keinoin:**
   a. **Muutosjohtaja, TIN:a tukeva hallintoelin, varmistaa että innovaatiopolitiikka tasapainoisesti tukee yrittäjyyttä, vahvistaa olemassa olevia kilpailuetujamme, ja edesauttaa uusien markkinoiden luontia Strategisten innovaatioaloitteiden (SIA) avulla. Muutosjohtajan keskeisenä tehtävänä on vahvistaa innovaatiojärjestelmän kyvykkyyksiä kansallisella tasolla. Tekesin tulisi isännöidä Muutosjohtajan toimintaa.**

Kuva 6. Lean National Innovation System, tapaus Suomi.



b. **SIA:n johtoryhmät koordinoivat SIA-toimintaa. Kunkin aloitteen puheenjohtajuuden tulisi mahdollisuuksien mukaan pysyä ministeriössä ensisijaisena vastuunaan aloitteeseen liittyvät lainsäädännölliset ja rahoituskysymykset. Johtoryhmän sihteerin tulisi olla Muutosjohtajatoiminnan jäsen. Johtoryhmän tulisi kokoontua vähintään neljännesvuosittain.**
c. **SIA:n orkestroijat sitouttavat osallistujat SIA-toimintaan kyvykkyyksien rakentamiseksi vahvistaen Suomen toimintaedellytyksiä kansainvälisissä verkostoissa. Riippuen aloitteesta orkestroija valvoo yhtä tai useampaa ryhmää, joiden kautta toimenpiteet toteutetaan. Orkestroijan tulisi olla omalla alallaan korkeasti arvostettu,** ja hallituksen tulisi kutsua hänet suorittamaan orkestrointitehtävää.

Tekesin rooli Muutosjohtaja-toiminnan isäntänä tulee olemaan erityisen tärkeä kyvykkyyden rakentamisen yhdistämisessä eri Strategisissa innovaatioaloitteissa. Seuraavassa esittelemme joitakin konkreettisia ehdotuksia siitä, miten tämä kyvykkyyden parantaminen voidaan toteuttaa.

2. **Muutosjohtaja-toiminnan isäntänä Tekes ottaa vastuun hallinnollisen kyvykkyyden rakentamisesta Suomen julkisella sektorilla toimintaoppimisen kautta alkaen uuden käytännön aloittamisesta valituissa Strategisissa innovaatiohankepiloteissa.**

Kyvykkyyskarttaa (kuva 1) voidaan käyttää operatiivisena välineenä keskittämään kyvykkyyden kehittäminen tehokkaalla tavalla. Tämä tarjoaa paremman tavan ymmärtää, miten Team Finlandin roolit ja vastuut voidaan määritellä ja tiedottaa paremmin Team Finlandin toiminnan tehostamiseksi.

Muutosjohtajan rooli on tarjota orkestrointitukea kansalliselle innovaatiojärjestelmälle. Tämä uusi Tekesin rooli edellyttää ennen kaikkea markkinoiden ja ekosysteemien yhdessä luomisen operatiivisten mittareiden kehittämistä. Tämän tehtävän käsittelemiseksi dynaamiset kyvykkyydet tulisi rakentaa perustamalla puolipysyvä osaamisallianssi: Seurantaryhmä, jossa sekä kotimaiset että ulkomaiset asiantuntijajäsenet tukevat Muutosjohtaja-toimintaa rakentavan kritiikin avulla jatkuvasti arvioimalla, miten suomalainen innovaatiojärjestelmän muutos etenee.

3. **Innovaatiojärjestelmän muutoksen vastuullisuuden, yhtenäisyyden ja läpinäkyvyyden turvaamiseksi perustetaan erillinen Seurantaryhmä, jonka tavoitteena on kriittisesti seurata ja tukea suomalaisen innovaatiojärjestelmän uudistuksen edistämistä.**

Jotta innovaatioympäristö olisi houkutteleva, sen on oltava aktiivinen kansainvälisessä vuorovaikutuksessa. Keskeinen tekijä pyrkimyksissä innovaation huippuosaamiseen Lean National Innovation Systemissä on maailmanlaajuinen verkottuminen huippuyliopistojen ja tutkijoiden kanssa. Valittaessa Strategiset innovaatioaloitteet, niiden tulisi luonteeltaan olla sellaisia, että ne ovat nopeasti uudelleen konfiguroitavissa julkisen ja yksityisen sektorin yhteistyöllä, johon yksittäiset kansalaiset vahvasti osallistuvat. Tällöin myös tutkimuksen rooli on muuttumassa. Emme enää puhu perinteisestä lineaarisesta tutkimuksesta vaan toistuvasta toimintatutkimuksesta. Kansainvälisten tutkijoiden houkuttelemineen olisi siten nopeaa, millä saavutetaan konkreettisia tuloksia. Suomella on tässä kilpailuetu teollisuuden, hallinnon ja tutkimuslaitosten välisen vakiintuneen yhteistyöprosessin ansiosta. Tämä muodostaa perustan uudelle näkökulmalle siitä, miten jakaa tutkimusresursseja innovaatio-ohjelman tukemiseksi.

4. **Team Finlandin toimijoiden, Suomen yliopistojen ja VTT:n tulisi olla strategisia kumppaneita globaalien ekosysteemien muodostamisessa, joita tarvitaan Strategisten innovaatiohankkeiden onnistumiseksi.**

Yliopistojen ja VTT:n kansainvälisen yhteistyön käytäntö on vahvasti perustunut alhaalta ylös -näkökulmaan ja yksittäisten professoreiden kykyihin solmia kansainvälisiä yhteyksiä. Integroimalla yliopistot aktiivisemmin Strategisten innovaatioaloitteiden muodostamiseen tulee näiden aloitteiden houkuttelevuus olemaan huomattavasti suurempi kansainvälisestä näkökulmasta erityisesti, mikäli osallistuvat globaalit yritykset tukisivat yliopistoja niiden pyrkimyksissä rakentaa tarvittavat kansainväliset yhteistyökanavat.

5. **Muodostettaessa Strategisia innovaatiohankkeita Team Finlandin jäsenten tulisi olla keskeisiä toimijoita kansainvälisten yhteistyökanavien luomisessa, minkä kautta sekä kaupallista että tutkimusyhteistyötä voidaan ajan mittaan vahvistaa. Yliopistojen ja VTT:n tulisi myös sitoutua tukemaan kaupallisten yhteistyökumppaneiden aikatauluja ja vaatimuksia ekosysteemeissä.**

Innovaatioympäristön houkuttelevuus substanssialueella rakentuu ajan mittaan. Tämä prosessi vaatii valtiolta joustavaa työkalupakin käyttämistä resurssien tarjoamiseen, markkinoiden ja ekosysteemien yhdessä luonnin tukemiseen sekä tarvittavien kyvykkyyksien rakentamiseen. Tällaiset ekosysteemit tulevat jatkuvasti edellyttämään sosiaalisia innovaatioita. Terveys ja hyvinvointi, liikenne ja kiertotalous ovat esimerkkejä yhteiskunnallisista haasteista, joissa lopullinen tulos on riippuvainen julkisen ja yksityisen sektorin välisestä yhteistyöstä. Tulokset riippuvat myös yhä enemmän poliitikkojen kyvystä käynnistää yhteiskunnallinen ja käyttäytymiseen liittyvä muutos. Kun tällaiset muutosprosessit käynnistyvät, ne tarvitsevat uusia tukimuotoja. Tämä tarjoaa Suomen innovaatiotoimijoille merkittäviä mahdollisuuksia nousta johtavaksi maaksi tällaisen monimutkai-

sen yhteistyön käytännön orkestroimisessa. Yliopistojen ja tutkimuslaitosten yhdistäminen näiden yhteiskunnallisten innovaatioiden tulosten todentamisessa ja uuden tiedon levittämisen nopeuttamisessa edistää Suomen vahvistamista innovaatioympäristönä priorisoiduilla substanssialueilla.

Kun otetaan huomioon, miten innovaation tukitoimet tulisi toteuttaa paikallisesti, väitämme, että on olemassa alueellisia eroja. Tarve koordinoida paikalliset aktiviteetit kansallisten tukitoimien kanssa on monimutkaisempi kuin nykyinen Team Finland lähestymistapa, jossa vain käsitellään alueellista/kansallista yhteistyötä Team Finlandin näkökulmasta. Nopeasti kasvavalle yritykselle viennin tuki, pakolaisten palkkaaminen työntekijöiksi, mahdollisuus investointitukeen ja ympäristölainsäädännön sovellettavuus voivat olla olennaisia kysymyksiä nykyisissä keskusteluissa ELY-keskusten kanssa. Kuten tämä esimerkki osoittaa, ELY-keskuksen vastuut yksittäistä asiakasta kohtaan ovat paljon laajemmat kuin Team Finlandin agenda. Pyrkimys toteuttaa erillistä kansallista/alueellista järjestelmää vain Team Finlandia varten aiheuttaa sekaannusta ja lisääntynyttä byrokratiaa.

6. **ELY-keskusten rooli Team Finlandin yhteydessä olisi käsiteltävä tulevan kansallisen ja alueellisen integraation laajemmassa valmistelussa, joka perustuu terveys-, sosiaali- ja alueellisen hallinnon uudistamiseen. Tulevaisuuden maakuntien kyvykkyyksien rakentamisen tarpeet tulisi jo sisällyttää Muutosjohtajan kyvykkyyksien rakentamisen tiekarttaan.**

Kaikki tässä arviointiraportissa esitetyt neljä Strategista innovaatioaloitetta ovat sellaisia, jotka suosivat paikallisten pilottien tekemistä kansallisella ohjauksella. Oikein orkestroituina nämä ponnistelut edistäisivät myös kansallista kyvykkyyksien rakentamista kunkin osaamisalueen sisällä.

Tämän vaikuttavuustutkimuksen päätavoitteena oli "tuottaa tulevaisuuteen katsova arviointianalyysi siitä, miten Tekes ja Team Finland ja niiden kumppanit onnistuvat tavoitteissaan tehdä Suomesta houkutteleva innovaatioympäristö". Tässä raportissa olemme esittäneet viitekehyksen tällaiselle uudelle innovaatiojärjestelmälle, jota kutsumme nimellä Lean National Innovation System. Yhdessä me kirjoittajat katsomme, että tehty tutkimus on osoittanut miksi ja miten Suomen kansallinen innovaatiojärjestelmä tulisi muuttaa. Esitetyt suositukset edellyttävät kuitenkin merkittävää sitoutumista ylhäältä ehdotetun muutoksen toteutumiseksi. Siksi poliittinen sitoutuminen on taattava ennen kuin päätetään, miten suosituksiin perustuen edetään. Jos poliittista sitoutumista löytyy etenemiseen, seuraava askel tulisi olla varmistaa, että marssijärjestys on tahdissa muiden käynnissä olevien Suomen valtion uudistusten kanssa. Oletamme, että kuuden kuukauden pilottivaihe riittää Lean National Innovation System -toimintamallin mukaisen muutosprosessin toimeenpanemiseksi. Kolme keskeistä aktiviteettia tulee pilottivaiheen aikana toteuttaa samanaikaisesti:

1. Hallinnollisten rakenteiden toimeenpano, erityisesti Muutosjohtaja-toiminnan organisointi.
2. Toimintasuunnitelmien ja valmiuksien laatiminen valituista Strategisista innovaatioaloitteista.
3. Uusien ideoiden ankkurointi keskeisten innovaatiotoimijoiden parissa, kuten Team Finlandin organisaatioiden, asianosaisten ministeriöiden, johtavien yliopistojen, keskeisten sosiaali- ja terveydenhuoltopiirien sekä valittujen sidosryhmien ja kansalaisjärjestöjen.

Perustuen kokeneiden ammattilaisten tehokkaisiin ponnisteluihin uskomme, että tässä esitetyt suuntaviivat voidaan toteuttaa aktivoivaksi toimintalinjausasiakirjaksi, josta voi tulla perusta Suomen innovaatioympäristön nostamiseksi seuraavalle tasolle. Käyttämällä etenemisessä pilottikohteina Strategisille innovaatioaloitteille esitettyjä ehdokkaita (Sosiaali- ja terveysjärjestelmät, Kaupunkiliikenne, Sopeutuvat valmistusjärjestelmät (Adaptive manufacturing ecosystems), sekä Kiertotalous ja kierrätys) uskomme, että nopea kehitys olisi mahdollinen. Toimimalla yhteistyössä toimijoiden kanssa, jotka ovat oleellisia näiden aloitteiden ympärille muodostettaville ekosysteemeille, olisi mahdollista testata prosessia alusta alkaen toimintaoppimisen kautta, mikä olisi ominaista Lean National Innovation Systemille.

Part I

Innovation environments

What are the main factors of an attractive innovation environment?

An attractive innovation environment requires active, international interaction. To pursue excellence in the innovation environment there is a need for global networking with top universities, researchers, and companies. The resources of the innovation environment must be sourced globally. To achieve this, there must be high-class governmental capability. By acting as a "public entrepreneur", a public-sector actor can be critical in co-funding the requisite research and disseminating the knowledge needed for small and medium sized enterprises to establish a presence in emerging ecosystems.

The long-term sustainability of a business ecosystem depends on how strong its dynamic capabilities are. Dynamic capabilities are the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets (Teece, 2007). Market creation, and co-creation, is the dynamic capability par excellence, the mother of all dynamic capabilities (Pitelis, Teece, 2016). Governmental capability (Honadle, 1981) is the ability to anticipate and influence change, guide future actions (i.e. sensing), make informed, intelligent decisions about policy; develop programs to implement policy (i.e. seizing); attract and absorb resources; manage resources; and evaluate current activities (i.e. configuring).

Prioritizing capability development calls for the categorization of capabilities. We will divide the capabilities into leadership and operational capabilities. In respect of operational capabilities, the categorization considers whether they relate to the external or internal perspective and are geared towards the resource or market dimension of the value creating activities. An illustrative capability map is presented in Figure 1 (the dynamic capabilities are indicated in red and the ordinary capabilities in blue).

Figure 1. An illustrative capability map (based on Honadle, 1981, Teece et al, 1997, and Wallin, 2000, 2005).

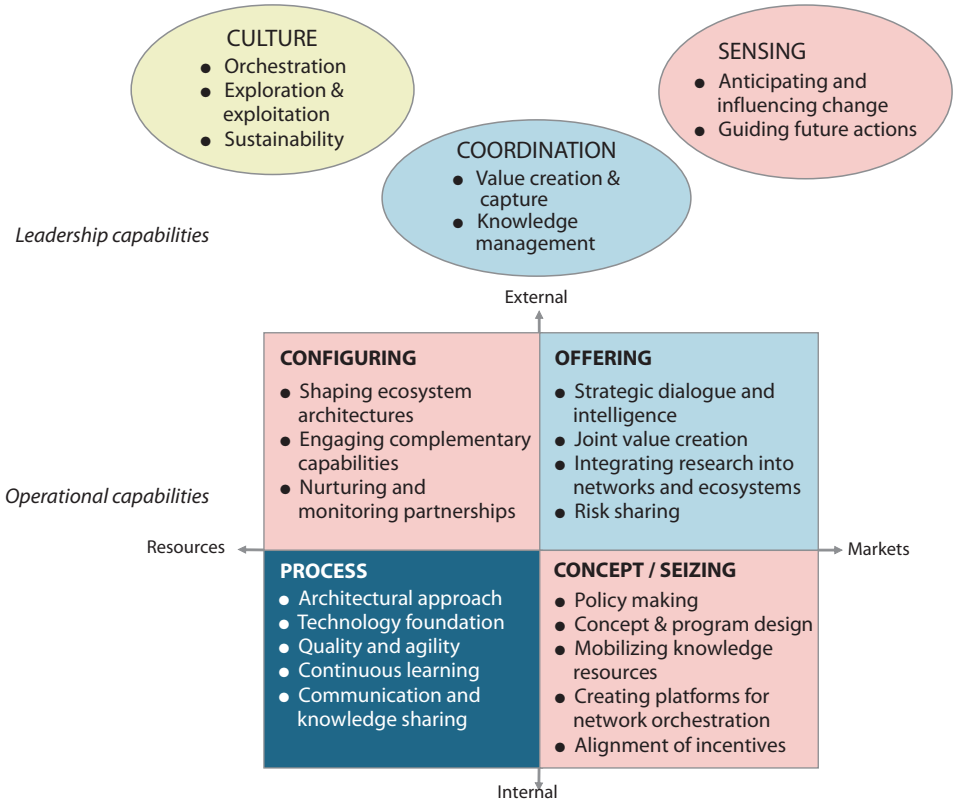
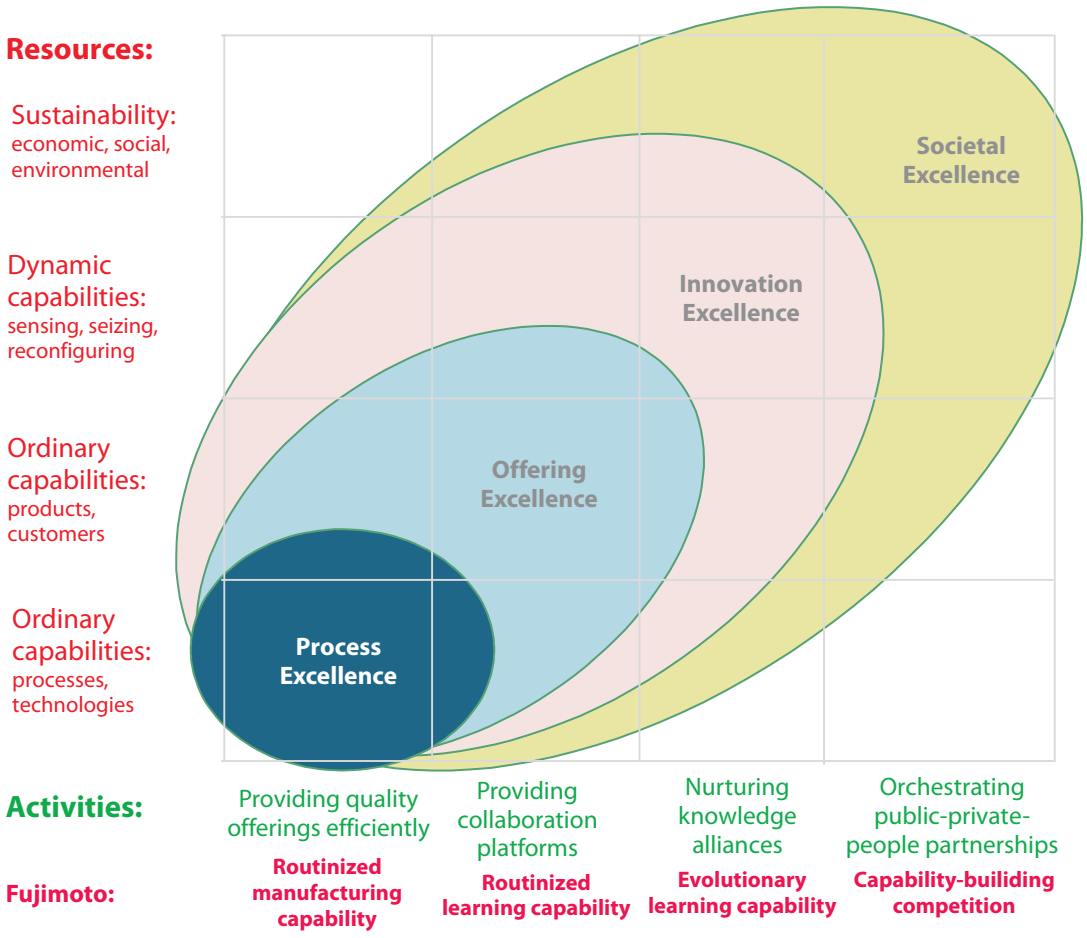


Figure 2. The Excellence Framework (based on Synocus research).



A tendency towards shifting emphasis from industrial process efficiency to a focus on sustainability can be identified in the way the innovation policies have evolved in the western world. There is a gradual shift from an initial focus on process excellence, towards a more complex understanding of excellence, also including offering excellence, innovation excellence, and societal excellence. Based on this, we have developed what we call the Excellence Framework, which is a tool to identify what issues are of importance in an attractive innovation environment. The Excellence Framework is illustrated in Figure 2:

The present trend is towards mission-based innovations, with public sector institutions as both participants in and funders of the innovation process. This is achieved through decentralized government efforts that rely on networks that cut across the public-private divide. This requires public sector officials to play a multiplicity of roles in supporting entrepreneurial efforts.

An attractive innovation environment (AIE) is an environment in which it is attractive to innovate, i.e., an environment (region, country etc.) with a high level of innovation activity. This definition is possible to implement empirically, provided that innovation activity can be measured. It also has the advantage that we can use established innovation theory & research to discuss how such an environment works (Fagerberg et al 2004) and what impacts various types of policy interventions may be expected to have (Edler et al. 2016).

However, politicians do not normally care about innovation for its own sake, but because of the beneficial social and, not least, economic impacts that it is generally assumed to have. Therefore, to function as a goal for policy, the definition of an AIE needs to include this dimension. Thus, following this, an AIE is an environment in which a high level of innovation activity is associated with beneficial social and economic effects.

That high innovation activity and good economic performance go hand in hand may be intuitively appealing, but is not always the case in practice. To delve a bit further into this relationship Figure 3 plots innovation activity (high versus low) against economic performance (unsatisfactory/good).

Figure 3. Attractive Innovation Environments and the "European Paradox".

	Economic performance: Unsatisfactory	Economic performance: Good (dynamic)
High Innovation Activity	European "Paradox"	Attractive Innovation Environments (AIE)
Low Innovation Activity	Large part of the developing world, many European regions	Low-wage regions embedded in global value chains

The top right quadrant of Figure 3 combines a high level of innovation activity with virtuous economic dynamics, i.e., an attractive innovation environment (AIE) as defined above. That is of course what policy-makers aim for. But many, if not most, countries or regions in the global economy are not so lucky. In fact, large parts of the world share the opposite characteristics, low innovation performance and unsatisfactory economic performance, i.e., the bottom left quadrant. This holds not only for a large part of the developing world but also many European regions (periphery, rustbelt etc.). Some low-wage countries combine relatively low innovation activity with high economic growth, though. However, to become attractive environments, these countries, which exploit low wage costs to engage in "catching up" processes, will need to substantially upgrade their innovation capabilities, as, for instance, China is currently doing. Finally, there is the less virtuous category in the top left which consists of countries and regions with seemingly well-developed innovation capabilities (as reflected in R&D as a share of GDP, for example) but with an unsatisfactory economic performance when measured in, say, growth in GDP or employment. Many European countries, consider themselves, to belong in this category and this may, arguably, also hold for Finland. The term "European Paradox" has been used for this apparent mismatch between innovation & economic performance. In such cases, innovation policy would contribute to moving the country or region from the top left to the top right quadrant.

The "European Paradox", however, may not be so paradoxical after all. Admittedly there are some economic theories that predict that high R&D investments will lead to rapid economic growth (Romer 1990). But these theories have a rather naïve view of the relationship between the creation of promising new ideas and their economic exploitation. In fact, Schumpeter's central argument was that it is not the creation of new ideas but their exploitation that leads to economic gains and such exploitation is very challenging (Fagerberg 2003). Thus, to understand innovation – and its economic effects – it is necessary to have a broad notion of innovation that encompasses the entire innovation cycle from the creation of new ideas to their exploitation and diffusion in the economic and social system (Freeman 1974, Kine and Rosenberg 1986). It is likely that some of the missing economic effects of innovation and the policies designed to support it are a consequence of a far too narrow focus among policy-makers and analysts with respect to the main challenges for innovation policy.

The following presents some central insights from innovation theory and research that may be of importance for the design and execution of innovation policy (and particularly for realizing the goal of AIEs):

- AIEs are open systems. Much, if not most, of the relevant knowledge originates outside a country's or region's borders. However, the exploitation of such foreign knowledge in innovation is no trivial matter. Practicing "openness" is not a substitute for domestic capability building.
- AIEs–or National and regional innovation system—may be "closed" not only to foreign but also to domestic or local talent, capabilities, and resources. The ability to mobilize a broad set of local actors with different backgrounds in the innovation journey may be critical for the outcome.
- National innovation systems evolve over long periods through interaction between the economic and political system of a country and, though they perform many of the same functions, they may nevertheless be quite different in terms of structure and how things are done. Attention to context is essential in design and implementation of policy. Mechanical transfer of policy practices across countries may easily do more harm than good.
- Innovation depends on several different factors to succeed and these are complimentary. A broad, holistic perspective will be required that allows for the identification of possible bottlenecks or "blocking factors" (Bergek et al 2008).
- The fact that policy instruments interact also means that evaluations of individual policy instruments are unreliable (Edler et al 2016) and need to be substituted/complemented by system-level evaluations (Fagerberg, 2016).
- Innovation is characterized by uncertainty and this is a major hampering factor, particularly when it comes to radical innovation. Demand-based policies, such as public procurement or, also, standards and regulations of various sorts can reduce uncertainty, provide opportunity, and unleash innovation. Opportunities for innovation can also emerge from policy goals that politicians set for society's development such as e.g. the transition to a sustainable economic system.

- Opportunities may also arise from technological revolutions, the ICT revolution and green-tech revolution, and, not least, the combination of the two, for which Finland may be excellently placed.
- An effective innovation policy requires the mapping of opportunities, innovation effects of public policies, and close coordination of policy across many different domains and levels of governance. This is obviously very demanding and raises the question of how the capabilities of innovation agencies and government more generally can raise to the challenge. With respect to policy coordination, Finland is considered a forerunner and its experiences ought to be more widely shared.

There are three key elements of an attractive innovation environment: resource provision, market co-creation, and orchestration/capability building (see Figure 4). These must be reinforced by both national and regional governments. The critical questions when deciding how to support innovation are then:

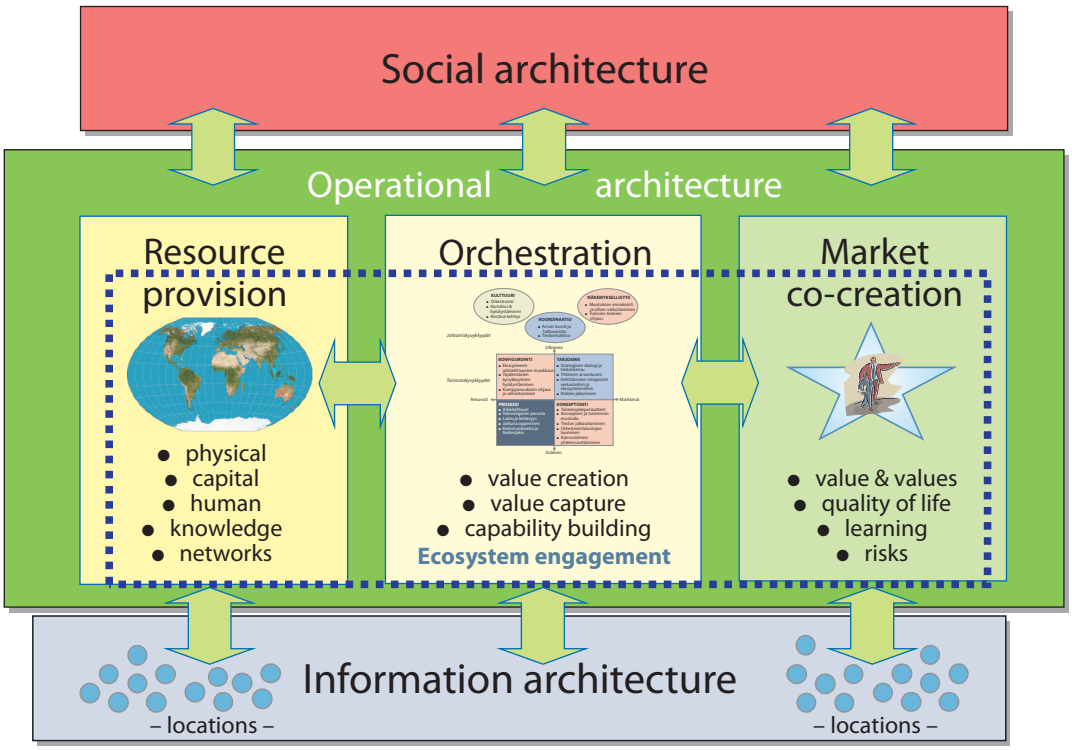
- Which business sectors should be supported?
- What mix of support (resource provision, market co-creation, and orchestration/capability building) should be applied in the chosen business sectors?
- How should the support implementation be monitored and adjusted based on actual results?

There is a need to focus on building organizational capabilities that allow the government to create the capacity for continuous innovation, as the new game concerns increasing both efficiency and innovation at the same time (Prahald, Krishnan, 2008). In Figure 4 we have used the orchestration framework (Wallin, 2006) to describe the integration of the various elements forming an attractive innovation environment (for a more profound "grounding" of the here presented framework for attractive innovation environments see Appendix 1).

The resources embedded in social relations among people and organizations that provide a common language and trust, and facilitate collaboration among the individuals engaged in a value constellation, form the social architecture (Wallin, 2006). The formation of symbiotic partnerships is needed to mitigate the long-term threat of environmental degradation and enable social transition (Perlmutter, Trist, 1986). Symbiotic partnerships is one of the key characteristics of an attractive innovation environment.

An architectural approach means that small steps, taken one at a time, can lead to significant new capabilities over a very short period of a few years. But such changes must be directionally consistent, they must be architected. These changes also require individuals who can monitor and steer the evolution based upon a systemic view of the innovation environment. Only by investing in people, or-

Figure 4. The Orchestration Framework (based on Wallin, 2006).



chestrators, who can play this transitional role are the needed knowledge transfers likely to happen (Lerner, 2012). As nodal networks or orchestrated ecosystems are becoming the norm, the managerial focus in the network shifts from ownership and control to access and influence to effectively leverage a global resource base. Simultaneously, the nature of an attractive innovation environment is shifting from technological supremacy to solutions to personalized, co-created experiences (Prahalad, Krishnan, 2008).

What are the success and failure factors of the Finnish innovation environment?

We will, in the following, discuss the success and failure factors of the present Finnish innovation environment, based on the interviews and case studies done during the impact study. We present the comments from the interviews on each of the three elements of our conceptual framework: resource provision, market co-creation, and orchestration and capability building.

Resource provision

The primary role of Tekes is to provide resources to the innovation processes. This applies to the other members of Team Finland as well. In the interviews carried out for the impact study it was recognized that Finland has traditionally been perceived to be a strong industrial society, partly based on its access to natural resources in the form of forests, water, minerals, and metals. It has also been a leading country in terms of patents per capita and problem solving (R&D) has been part of its DNA. However, this has implied a mindset more geared towards invention than taking the new product/service to the global market.

New opportunities identified by the interviewees are open data, provided by the authorities; biobanks attracting companies to come to Finland; and a stronger collaboration across various actors in the public sector to support innovations.

Major problems still relate to providing financing for startups and smaller companies so that they could grow to a decent size. It is also seen as a problem to have the foresight and insight to allocate attention to such sectors, actors, and markets where Finland has the possibility to make a difference. Too much effort seems to be devoted to various forms of organizational arrangements between different actors within the public innovation system.

Market co-creation

Interviewees' reflections on the contribution Tekes and Team Finland have made to market co-creation revealed that RDI activities increasingly take place in various forms of networks, which also involve public-sector actors. Such networks are ever increasingly formed based on market pull, rather than on the principles of scientific or technology push. A successful case in the formation of such an innovation network was the development of the first LNG ship, Viking Grace, which became a valuable reference case for the Turku shipyard. Similar contributions in the marine sector were the formation of the Norwegian Finpro office, aiming at the offshore sector, and a project office in Saint-Nazaire, where, consequently, SMEs from Finland gained significant business. Finpro's growth program has also helped the same subcontractor firms secure sizeable deals with the Mitsubishi shipyard cruise ship projects.

Several interviewees highlighted the innovation potential of the SOTE reform. It was seen that the digitalization of healthcare, the e-health system, and biobanks could be used as catalysts enabling the government, universities, genome centers, and companies to all work around a shared vision. SOTE, with integration of health and social sectors, could be an excellent operating and innovation environment as well as leverage innovation activities by supporting stronger centralization and related system-level innovations. The Social and Health Care Ministry has developed considerably and they understand the innovation and growth aspects in the health sector.

Another identified opportunity is in the Ministry of Transport and Communications' efforts to reform transport-related regulations ("Liikennekaari").

Orchestration and capability building

Many interviews touched upon the possible roles of Tekes and Team Finland as orchestrator. It was seen that a key challenge for the Finnish economy is instilling a stronger belief in the future into the country; this requires a broader, shared vision which will guide our efforts to succeed in global competition. The Team Finland actors need to be aligned, but they also suffer from the same problem—it is difficult to align independent institutions and funding without an overarching vision. The cooperation between big companies, universities, and small companies should also be integrated with Team Finland collaboration.

Fragmentation is a challenge. Finland has many components: infrastructure, financing, regulations, and collaboration. However, these are not structured to offer international customers a one stop shop, simplifying the process of signing contracts. However, the greater challenge is that the components are too fragmented, not aligned around a vision. It is difficult to paint the picture for international investors.

The need for some form of industrial policy is considered very important. There is a need to select those competence areas wherein Finland can provide some new innovative solutions, which could create export business and strengthen the Finnish economy. One must identify what competence areas (general purpose knowledge) will be important in the future and enable high-quality research and

development in these areas. The present spearheads bio, cleantech, digi, and health, the BCD-H vision, is on an abstract level. It is crucial that Finland carry out large systemic programs, which will create cultural change in how R&D&I is perceived and results which are adopted by the industry on a larger scale.

The extent to which incumbents will be able to make the transition, when looking for new openings, was also questioned, this will also require new tools and new ways of working. This also applies to Team Finland, which has evolved gradually. But it is still unclear what the ultimate role of Team Finland should be.

The role of Tekes as an ecosystem orchestrator was also discussed. The question is whether Tekes can, due to its regulated position, genuinely take such a position, as ecosystems will ultimately need financial and business objectives as well as activities. For example, the role of playmaker in the health field is contested. Recently, Tekes has also strived for this role, a problematic move, as it can subsidize this role to a much greater extent than other organizations, but is still a financer. A financer, like Tekes, needs to be humble and listen to its customers, it shouldn't be a "besserwisser".

How have RDI investment decisions been made between small advanced countries in Europe? Why have international/Finnish companies chosen Finland or some other innovation environment in Europe?

The basic infrastructure of the Finnish innovation environment is good (technology, education, digitalization, research, financing, regulation, university/industry-collaboration). However, these elements are not, necessarily, always properly coordinated. Finland is better at inventions than addressing global market needs. This may also be due to a financing practice which supports startups and smaller companies, but is much less effective in supporting the growth of companies over the 50-employee mark. In general, we should be better at integrating our financial policies and innovation polices to improve the capacity for allocating our resources to those areas where there is the highest probability for economic success. Those countries that are now successful in their innovation policies, e.g. South Korea and Singapore, seem to have strong integration between innovation policy, research and education policy, and economic policy.

The paradox of today's world, with fast technology development and vast amounts of information, is that the role of key individuals is increasing; individuals with relevant experience and insights and deep understanding (näkemys in Finnish) are key success factors. Finland must be more selective in its innovation support activities and allocate funds to those who can make a difference, also accepting that we cannot support everybody.

One of the main hindrances for a more positive development is the negative attitude and pessimism in the Finnish society. Here the public sector itself may be able to make an impact. There is a need to instil a stronger belief in the future of the country; this requires a broader, shared vision which will guide the efforts to make progress and succeed in the global competition. If we can provide a vision of the future and confidence in the capacity of Finland to once again become a leading actor internationally in selected sectors, then we have a good chance of re-establishing Finland's position as an innovation leader.

The Finnish innovation field is suffering from fragmentation. There are about 250 university research units in Finland that receive public finance. This is about the same amount as in the Netherlands, which has a population of 16,8 million people.

A total of seven case analyses were conducted for this study. Three categories of companies were analyzed.

The first category can be called *corporate R&D centers*. Intel, Zalando, and Huawei represent this category. Typical for the R&D centers is that the parent company has evaluated where to locate its R&D function and, based on thorough evaluations, has chosen Finland as the favorable location for R&D activities.

The second category we call *integrated acquisitions*. GE Healthcare, Vallox, and Meyer Turku belong to this group. These are companies with a long manufacturing history in Finland, that, at some stage, has been acquired by the present owner, who has decided to further strengthen the Finnish unit.

The final category we call *Finnish born globals*, represented by Aava Mobile. This is a company that was founded in 2009 with the ambition to serve the global market, based upon the vision of the founders who had a long history of international experience in global corporations.

Each company category has somewhat different motives for choosing Finland as an innovation location. For the *corporate R&D centers* we see that the resource provision offered by the location is the main point of attraction, illustrated by the following comments:

- Being attractive means you must have the entire ecosystem in place, including competent personnel, creative culture, broader startup ecosystem, supportive public sector. For Finland to stand out amongst the intense competition, there is still room for improvement. (Zalando)
- In April 2011, it was announced that Intel would open a Finnish R&D site as Nokia was cutting back. The initial announcement stated that some 200 staff would be hired. When Intel made its announcement, many noted that

Google, Skype, and Samsung had openly said that they too were seeking to tap into Finnish engineering talent looking for new jobs following Nokia's cut backs. (Intel)

- The Huawei research centre in Helsinki conducts research into mobile phone technology. Much of Huawei's research in Finland is currently focusing on 5G radio technology and data security. Other areas of R&D activity include graphics for mobile devices, mobile browsers and other web technology, user interface design related to consumer products as well as participation in Linaro. (Huawei)

We can see that the specialized knowledge, particularly in mobile and communication technology, has been the main driver for the initial decision to establish the R&D center in Finland. However, as the unit has become firmly established, it has also starts to exhibit increased attention to market co-creation possibilities:

- In pursuing new directions, Intel Finland has also tried to build new ecosystems e.g. with producers of moving machines in the Tampere area. Here it has proven to be quite challenging to get genuine engagement from the companies. It seems difficult for Finnish companies to envisage genuine win-win-win possibilities and the companies are, instead, more defensive and afraid that their knowledge will get into the hands of the other company, without them getting any of the benefit. This raises the question of how such ecosystems should be initiated and orchestrated. (Intel)

For the companies that represent *integrated acquisitions* in their respective corporations we see much stronger focus on the market co-creation aspect of the innovation environment:

- GE Healthcare Finland expects that HUS, in collaboration with the Finnish government, will be able to provide testbed services for GE in Finland. This would further enhance the possibilities of GE Healthcare Finland to gain increased attention within GE Healthcare and would also increase the Finland's attractiveness for other international health tech companies. This should then also be reflected in the public procurement contracts, so that genuinely new innovative technologies can be purchased through public procurement. (GE Healthcare)
- The strong demand for Meyer Turku at present is based on two important incidents occurring prior to Meyer's acquisition of the Turku shipyard. Firstly, the evolution of a strong supplier network on the Finnish west coast, which has provided the Turku shipyard with network-level capabilities that can be effectively deployed for demanding customer requirements. Secondly, the support by the Finnish government for the development of new technologies e.g. relating to the first LNG ship, Viking Grace, which became a valuable reference case for the Turku shipyard. (Meyer Turku)
- Finland's demanding climate conditions (more demanding than in Central Europe) is a valuable background, through which the heat recovery competence has been developed, not only in Vallox but also in other leading companies such as Enervent, Swegon, and Iloxair (Fläkt Woods). The basic engineering competence in Finland is of a high-class. (Vallox)

Other aspects emphasized by the well-established units of international corporations are international networking and the establishing of global pipelines:

- Finland could also support the establishing of global pipelines. The managing director of GE Healthcare Finland has spent almost thirty years in China. Thereby, GE Healthcare Finland is well positioned to support collaboration in health tech issues between Finland and China. (GE Healthcare)
- Vallox is currently considering the development of a competence center that would also utilize international competences. (Vallox)
- The Turku shipyard is the core of the Finnish marine sector. Now, as part of the Meyer Group, the emphasis is on making the production process even more efficient. An investment program of €75 M has already been approved to improve the efficiency and shorten the production times for the Turku shipyard and more is in the pipeline. (Meyer Turku)

The final category, called *Finnish born globals*, is represented by Aava Mobile. This case shows how resource provision through the agglomeration of knowledge and relationships established in the companies where the founders previously worked, as well as funding from Tekes, formed the basis for the establishing of the company. What is of importance here is the notion that the relationships to leading global companies, essential in the formation of the ecosystem orchestrated by Aava Mobile, were established directly to the headquarters of international corporations; initially without any involvement of the local subsidiaries of these corporations. This emphasizes the importance of orchestrating on a global scale. For the innovation environment to be able to support such activities is a mayor challenge. This, however, also becomes a prerequisite for the formation of globally co-created new markets and ecosystems in the way Aava Mobile has been able to achieve with mobile point of sales platforms (MPOS). Aava Mobile explicitly states that it prefers stronger support in connecting the firm to an opportunity internationally than a domestic collaboration.

What are the main governmental-level policy targets and measures for the Finnish innovation environment over the next five years?

Based on the here presented dynamics of attractive innovation environments—consisting of a dynamic interplay of resource provision, market co-creation, and orchestrated capability building—we consider that the initiation of Strategic Innovation Initiatives will be the most important way to sharpen the focus of the Finnish innovation system over the next five years. In Table 1, we present a summary of four suggested cases as well as the role they could play in the Finnish innovation environment.

Table 1. Strategic Innovation Initiatives, illustrative candidates.

Strategic Innovation Initiative	Resource provision	Orchestration and capability building	Market co-creation	Key enterprises
Social and healthcare systems	• uniqueness of the Finnish healthcare system, particularly biobanks • contribution from ministries (Ministries of Employment and Economy, Social & Healthcare, Education) is crucial	• create a joint national vision and innovation agenda to establish portfolios of innovations/inventions • anchoring the development in a citizen-centric view • strong public-private-people innovation collaboration	• making the SOTE reform leverage innovation activities • what is needed is a one-stop shop for those that want to establish innovation activities	• HUS, Eksote, University of Helsinki, Aalto, GE Healthcare, IBM, Thermo Fisher, Planmeca, Ministry of Social Affairs and Health, THL, KELA
Urban transport	• alternatives to fossil fuel for vehicles, autonomous vehicles, and public transport systems • open data	• decentralized piloting in cities, centralized governed by Trafi • transport regimes as part of smart city paradigm	• the car as a digital platform in mobility service systems • blurring boundaries between public and private transport	• Trafi, HSL, City of Tampere, City of Turku, Here
Adaptive manufacturing ecosystems	• capability to rapidly adapt to global needs using supplier networks • public support for next generation technologies	• flexibly integrate many actors into a capability pool • "collective impact" efforts through knowledge alliances • orchestration based on trust to build new capabilities	• establishing architecture-based production networks • interaction with international experts opening new business opportunities	• Meyer Turku, Valmet Automotive, Turku Future Technologies, University of Tokyo, RWTH Aachen
Waste management and recycling	• expertise in handling hazardous waste • open data as raw material for waste handling logistics	• Circular Economy Village as catalyzing brand for global expansion	• regulation for increasing waste recycling as innovation platform	• Fortum/Ekokem, Valmet, Ladec, Enevo, CrisolteQ, Sybimar, ZenRobotics, Tsinghua University

What is a national innovation environment's role when business models and platforms are global?

What the firms and the governments need now seems to be a balanced view that focuses on both internal capabilities to establish technological-manufacturing competitiveness and intellectual property robustness in the closed-architecture area on the one hand, and external capabilities for exploring and exploiting attractive business ecosystems by offering effective industry-wide inter-component standards and finding competitive platform leaders or critical complementors in the open-architecture area on the other hand.

The policy framework for creating or supporting attractive innovation environments (Figure 4), with three pillars of resource provision, capability building, and market co-creation, is also very relevant for analyzing today's international competition and cooperation among firms and facilities.

(i) As for *resource provision*, the government may need the basic understanding of architectural (design-based) comparative advantages and allocate resources primarily to promising sectors regardless of conventional industry classifications. Considering the Finnish history of industrial evolutions that created coordination-rich techno-manufacturing sites, the government may need to pay special attention to the systems, products, modules, components or materials, whose architectures are internally-integral and externally-modular, regardless of conventional industrial classifications.

(ii) As for *capability-building*, the government will need to make sure that the resources it allocates are effectively used not only for developing core technologies of the future but also for creating good flows of design information (i.e. competitive value streams to customers) and enhancing both human and digital resources that create competitive technologies, architectures, value flows, property rights, and so on. We should keep in mind that traditional industrial policies tended to focus only on subsidies and tax benefits for core technologies and equipment, rather than capabilities for creating good flows of design information (Monozukuri in Japanese). As Edith Penrose once suggested, productive resources themselves do not result in international competitiveness, unless they create productive services through the efficient use of productive capabilities.

(iii) As for *market co-creation*, the government will need to help the leading and supporting firms find and attract growing markets, promising customers, core suppliers, and key complementors on the global scale for creating various socio-economic values. The government and the firms may jointly explore new and attractive business ecosystems in which Finnish firms can take leading roles, or exploit them by making Finnish firms and products attractive to the customers and leading complementors.

In any case, the main roles of the government's industrial/innovation policies would include both organizational capability building and effective demand creation at all layers of the economic systems—national economy, industries, firms, and manufacturing sites (Fujimoto 2012). This means that the government should pay attention not only to big-scale innovation projects that involve major universities and governmental institutions but also to *grass-roots innovations* that numerous factories, facilities and small and medium-size enterprises, embedded in the local communities, launch for improving productivities for their own survival and stabilizing employment for the communities at the same time.

Different types of capabilities and architectures suit some better than others and this affects the international competitiveness of factories or product development facilities—the policy that considers the concept of *design-based comparative advantage* (Fujimoto 2007). Thus, such industrial policies should be two-sided, as is always the case in strategic management—(i) concentrating the resources on the products and services that have competitive architectures with existing capabilities, and (ii) building new capabilities for making the previously-uncompetitive products competitive in terms of their relative capability-architecture suitability.

In Japan, the government has through the Council for Science, Technology and Innovation in May 2014, established the Cross-ministerial Strategic Innovation Promotion Program (SIP). This is a national project for science, technology, and innovation, spearheaded by the Council for Science, Technology, and Innovation as it exercises its headquarters' function to accomplish its role in leading science, technology and innovation beyond the framework of government ministries and traditional disciplines. The SIP has identified ten themes that will address the most important social problems facing Japan, as well as contribute to the resurgence of the Japanese economy. Each project is led by an experienced and talented program director who is responsible for end-to-end focused research and development, facilitating coordination among government, industry, and academic entities. These directors have been charged with guiding their project from basic research to practical application and commercialization, and ultimately to a clear exit strategy. The SIP focuses on science, technology, and innovation, which drive Japan's economic growth and vitality and which will dramatically change society.

The challenges facing national innovation systems are multidimensional and complex in their nature. The government of Japan has, for example, made the following observations and decisions (CSTI, 2016):

- The Science, technology, and innovation (STI) policy is one of the major national policies for the economy, society, and the public that will enable a country to shape a better future. Therefore, it is essential to policy promotion that the policies clearly present what kind of country is to be achieved and share this profile with its citizens.
- At the present era of drastic change the process of creating knowledge and value has changed considerably. The development of information and communications technology (ICT) is now changing economic and social rules in the blink of an eye, while also impacting lifestyles and the very existence of society and humanity. Innovation is now manifesting itself in places beyond the traditional boundaries and is spreading across the world almost instantaneously.
- As the Japanese economy and society matures, values are diversifying, with people's interests shifting from the tangible to the intangible.
- When creating new knowledge and value, it is increasingly important to form and act in teams by bringing together people with diverse expertise. There is a need to engage the various stakeholders of society in dialogue and collaborate with them in promotion of STI activity.
- When deploying STI to address various economic and social issues, new initiatives for industry, academia, government, and relevant ministries to work together in R&D and social implementations have been advanced, such as the Cross-ministerial Strategic Innovation Promotion Program (SIP).
- CSTI is furthering cooperation and collaboration with the Headquarters for Healthcare Policy, as well as with the ICT-related command center, the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society, and the National Center of Incident readiness and Strategy for Cybersecurity. Together with laying the foundation for a cooperative network encompassing industry, academia, and government, as well as with the relevant ministries for building the super smart society service platform, CSTI prioritizes initiatives and sets detailed targets in its Comprehensive Strategy, which is formulated each fiscal year.
- Japan needs to raise its international profile. STI must be strategically utilized in international collaboration to help address both domestic and international issues.

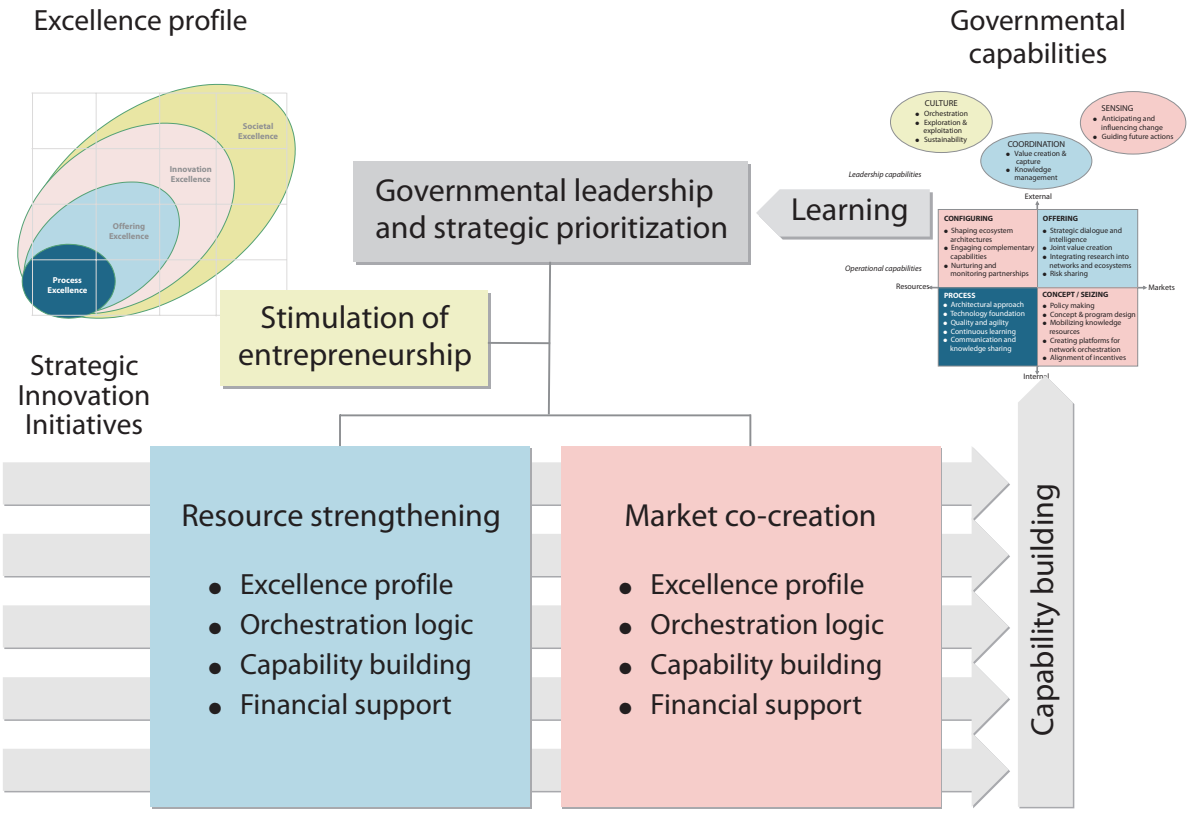
The Lean National Innovation System

Based on the findings from the literature review, the interviews, the case studies, and the benchmarking of five countries: Sweden, Norway, the Netherlands, Belgium, and Japan (Appendix 2) we can summarize the results of our investigation about the nature of an attractive innovation environment into what we here will call a Lean National Innovation System.

The resources of the Lean National Innovation System must be sourced globally based on the national interest. The main elements of a Lean National Innovation System are resource provision, orchestration and capability building, and market co-creation. To integrate this there is a requirement for high-class governmental capability. By acting as a "public entrepreneur" a public-sector actor can be critical in co-funding the requisite research and disseminating the knowledge needed for small and medium sized enterprises to establish a presence in emerging ecosystems. Both resource strengthening and market co-creation must be monitored and steered based on the same principles. However, the excellence profile and capability map of resource strengthening is more geared towards offering excellence and ordinary capabilities, whereas market co-creation requires innovation excellence and dynamic capabilities. In market co-creation, public procurement, regulations, incentives, and innovative use of open data are more strongly emphasized. The Lean National Innovation System is illustrated in Figure 5.

In the second part of this report we will evaluate how well Finland exhibits the characteristics of such an idealized design (Ackoff, 1993) of an attractive national innovation environment such as the one we have portrayed here.

Figure 5. The Lean National Innovation System.



Part II

Evaluation of the Finnish innovation environment

The objective of the impact study is to produce a combined, forward-looking (ex-ante) evaluation analysis of how Tekes and Team Finland collaborators will succeed in reaching the objectives related to the goals of Tekes in contributing to Finland being an attractive innovation environment. To be able to provide this analysis, and subsequent recommendations, we have, in the first part of the study, identified those factors of innovation environments which are essential in the Finnish economy and society becoming attractive at the top level internationally. This resulted in an idealized design that we called the Lean National Innovation Environment. This idealized design provides the basis for us to evaluate to what extent the Finnish innovation environment possesses the characteristics of such an innovation environment.

The main goal of the evaluation is to produce an easily understandable impact study and communicable results for future actions. The recommendations should address the following questions:

- How can the Finnish innovation environment be improved in general?
- How can Tekes improve its impact on the Finnish innovation environment?
- How can the other actors of Team Finland (especially Finpro and Finnvera) improve their impact on the Finnish innovation environment?

The role of this second part of the report is to evaluate the status of the present Finnish innovation environment, and how well Tekes and Team Finland actors have contributed to the attractiveness of this environment. This will be done by discussing to what extent the characteristics of the idealized design, the Lean National Innovation System, already exist, or have been identified as potential future characteristics of the Finnish innovation system. We will structure the discussion to allow us to also address the explicit questions raised by Tekes when the impact study was initiated.

We begin by stating six propositions for the Finnish innovation environment. When discussing these propositions, we will use three different approaches to provide viewpoints on each issue. The first approach is through a meta-analysis. We have carried out an in-depth analysis of seventeen recent evaluation reports or impact studies conducted by Tekes, the Ministry of Employment and the Environment, and Sitra (see Appendix 3). The meta-analysis uses quotes from these reports to deepen the understanding of the relevance and nature of each of the presented propositions. The second approach will complement the findings from the meta-analysis with observations from the field, using various sources for additional perspectives on the questions raised. The third approach provides the authors' conclusions of the outcomes of the meta-analysis and other observations, and are occasionally complemented by recent quotes from the Finnish press. The synthesis also address the relevant question relating to how Tekes and Team Finland collaborators have succeeded thus far in reaching the objectives related to the goals of Tekes in contributing to Finland being an attractive innovation environment. In this way, we aim to secure that our analysis and evaluation is triangulated in the best possible way.

The six propositions we have identified based upon the Lean National Innovation System model are as follow:

Proposition 1. ***Finland is an example of the European paradox; this requires a rethinking of the national innovation system.***

Proposition 2. ***The rapidly changing context of national innovation environments requires stronger steering from the national government.***

Proposition 3. ***To enable the proper alignment of resources under control of the national government, there is a need to clearly define the priorities of the national innovation policy, which requires the support from a dedicated actor providing the government with views on how to steer the innovation policy.***

Proposition 4. ***The implementation of the innovation policy will simultaneously, through resource allocation in dedicated government-supported strategic innovation initiatives, co-create value in ecosystems and (new) markets, capture a relevant portion of this value in protectable national institutions, and contribute to knowledge creation and capability building.***

Proposition 5. ***The nurturing of the national innovation system will be handled by actors building governmental capability and supporting the government with continuous information about (i) the status of the system, (ii) the evolving operational context of the system, (iii) and to what***

extent there is a need to adjust the system to adapt to identified changes, internal to the system and in the external environment.

Proposition 6. ***The steering of the new national innovation system requires new tools and incentives, which should gradually be taken into use to secure an efficient transition from the old to the new.***

To integrate the six propositions with the original three questions to be addressed in the evaluation of the Finnish innovation environment we will structure this second part of the report around the following questions:

- How can we characterize Finland as an example of the European paradox? (proposition 1)
- How has the steering in the Finnish innovation environment progressed and what has been the role of Tekes in this? (proposition 2)
- How has prioritization in the Finnish innovation environment been carried out and what has here been the role of Tekes? (proposition 3)
- How have government resources been allocated for prioritized innovation areas and what role has Tekes here played? (proposition 4)
- How has governmental capability building taken place in the Finnish innovation environment and what has Tekes's role been? (proposition 5)
- What are the best tools and overall possibilities for Tekes to achieve the highest impact on the Finnish innovation environment? (proposition 6)
- What is the experienced impact of closer collaboration between organizations (especially Tekes, Finpro and Finnvera) over the next five years? (conclusions for the future based upon all six propositions).

The first mention of the notion of an attractive innovation environment in the agreement between Tekes and the Ministry of Economic Affairs and Employment was in December 2014. Thereafter, it was decided that Tekes would have two main objectives: *Dynamic renewal of business and industry*, and *Finland becoming one of the most attractive innovation environments in the world*. This second objective will be evaluated based upon external evaluations to be carried out in 2016 and 2018.

This impact study is thus the first to evaluate the extent to which Tekes has contributed to the attractiveness of Finland as an innovation environment. As neither the Ministry of Economic Affairs and Employment nor Tekes have explicitly operationalized the attractiveness of an innovation environment this was the first task of this impact study, resulting in the development of the Lean National Innovation System framework.

The need for a lean approach was also recognized when the agreement between the Ministry and Tekes regarding how Tekes will fulfil its objectives vis-à-vis the Ministry was updated in January 2016. In this agreement, the following activities were listed as measures to reach the objective of Finland becoming one of the most attractive innovation environments in the world:

- Tekes will support the implementation of the spearhead projects initiated by the government throsugh new efficient operational models.
- The roles and responsibilities among the actors of the Finnish national innovation system will be clarified and the collaboration will be intensified.
- Financing to large companies will, to an increasing degree, be allocated to the formation of new ecosystems and the development of the innovation environment.
- Collaboration will be intensified to attract large direct investments to Finland.
- A broad offering development effort will be carried out using service design and lean thinking.
- An efficient (lean) and digital customer service and production platform will be developed.

Subsequently, the evaluation presented in the following adheres to the two main lean principles, elimination of waste and full use of capabilities (Sugimori et al., 1997).

The three previous objectives of Tekes were to (i) contribute to productivity and renewal, (ii) build innovation capabilities, and (iii) promote wellbeing. All these objectives also supported the attractiveness of the Finnish innovation environment, but there was no need to explicitly evaluate their joint impact. Contributing to an attractive innovation environment calls for a different evaluation approach, as the attractiveness will be defined by external stakeholders, and can be only indirectly observed. This also reduces the relevance of an impact model based upon additionality, as the excellence sought for may not be achieved by merely adding the impact of individual factors, but is formed through complex systemic interrelationships among a multitude of factors. We will, therefore, subsequently also use the Excellence Framework as a complimentary tool to the impact model based on additionality. Additionality is a good way to evaluate efficiency, i.e. doing things well. Excellence raises the question of what other things might have been done, i.e. how to do the right things.

As the objective of contributing to the attractiveness of Finland as an innovation environment was only added to Tekes's remit at the beginning of 2015, it is too early to make any quantitative assessment of the extent to which Tekes's activities have contributed to the attractiveness of Finland as an innovation environment. However, by using the Lean National Innovation System framework as well as the proposals and questions derived from the framework, we can assess where Tekes has already exhibited strengths, and where there are areas identified that could provide future potential for Tekes to further increase the attractiveness of Finland as an innovation environment.

How can we characterize Finland as an example of the European paradox?

Meta-analysis

After a sharp drop in 2009, the economy recovered in 2010 and 2011, but failed to make up for the losses in exports and investment. However, Finland's financial system was stable and the country was considered a safe haven when the sovereign debt crisis started. Finland fell back into recession in 2012 which lasted until 2014. In 2015 real GDP is forecast to have bottomed out. A sluggish recovery is expected in 2016 and 2017, with unemployment staying above 9 % over the next years (European Commission, 2016, p. 1).

As the electronics sector was highly productive, its decline resulted in a significant drop in the overall productivity of the economy. Wages, however, did not adjust, but rather continued rising, based on a long-term agreement struck between the social partners in 'good times'. Since productivity did not increase rapidly either, unit labor costs rose sharply (by 19.2 % over 2008-2013) and Finland lost competitiveness and export market shares (European Commission, 2016, p. 1).

Finland has been hit by a combination of adverse shocks. The electronics sector contracted significantly when Nokia's handset business failed to rise to the competitive challenge of smart phones and collapsed. In addition, the Finnish paper industry suffered from a secular decline in demand for paper products. From 2014 onwards, exports to Russia almost halved due to the Russian recession and the imposed sanction regime. Finally, a rapidly ageing workforce results in a decline of the working-age population by 0.5% every year, which inevitably weighs on the growth potential in the long run (European Commission, 2016, p. 1).

Despite ranking high in various international comparisons, this has not been reflected in the Finnish economy or businesses life as renewal and competitiveness. Comparisons have increasingly indicated that our situation is weakening. Finnish science enjoys a relatively high position, but the leading countries have left us behind. The field of higher education institutions and government research institutes is fragmented and resources are used inefficiently. Regardless of our world-class innovation system, research environments of a high standard and other strengths, little foreign expertise and capital has been drawn to the country (Research and Innovation Council, 2014, p. 10).

The structural change of the Finnish industries and business sector, and the prolonged recession, have reduced economic resources and further impeded the implementation of social policy changes. There is little room for manoeuvre. Our long-standing strengths are not enough to tackle this crisis. The resilience of the society and national economy are being put to the test. Confidence in Finland, as an innovation-driven economy, should be revived: the competence that is a precondition for success must be rediscovered and the foundation of our economic life must be reconstructed (Research and Innovation Council, 2014, p. 6).

The prospects for longer term growth in Finland will require rethinking domestic institutions and policy. The Finnish "national system of innovation" appears to have become self-limiting in the global environment of the 2000s (Sabel, Saxenian, 2008, p. 112). A forward-looking innovation policy pays attention to the capabilities of the system to produce innovations in the future. Innovations influence productivity growth, social conditions, competitiveness, sustainable development, military force, health care, etc. Hence, innovations are important for what they can do with regard to other socioeconomic phenomena (Veugelers, 2009, p. 18).

For most, the success of this policy regime in fueling Nokia's rise to global leadership in mobile devices has ratified the classic endowment-based approach to economic policy. This view sees the economy as a giant production function with policymakers investing in increasingly sophisticated inputs, such as highly educated workers, support for basic and applied R&D, etc. In this view, as long as basic market protections are in place, these investments alone will fuel technological innovation. Tekes, along with Finland's universities and polytechnics, were the key institutional foundations for this national innovation system (Sabel, Saxenian, 2008, p. 111). Nokia was responsible for some 40 percent of total R&D spending in Finland in 2002 and held title to 70 percent of Finnish patents issued in the US, up from 40 percent in 1997. The spatial distribution of employment reflects Nokia's role as well. The dominance of a single firm might not be a problem if it was collaborating with other local firms and institutions. While Nokia directly and substantially contributed to enhancing productivity growth in the country, productivity gains outside Nokia and a few other IT-related service industries were small, temporary, or non-existent at all (Sabel, Saxenian, 2008, p. 115).

Finland's public and private institutions face a choice. They can continue to invest in the national innovation system as currently configured. This, we believe, will insure that the crisis now facing the forest products industry will shortly spread to the telecommunications and ICT sectors as well. There would be a silver lining: crisis and breakup of the largest firms will free up skill and expertise that can be redeployed into projects that, over time, could support the regeneration of local innovative capacity and renewed industrial opportunities. But the costs would be high in the interim (Sabel, Saxenian, 2008, p. 122).

If the national system of innovation is in crisis, as we believe it is, then the task is to develop institutions that encourage adaptation and learning instead of inertia. In this way, they can support firms in searches for customers, partners, and suppliers that can help define innovative and

unanticipated new technologies, products, and industries. **One crucial step towards doing this is, surely, for Finland to go beyond the current flurry of program creation and take the lead in exploring what a post-national system of innovation could be.** At a minimum that would require monitoring the successes and failures of the new institutions to catch missteps early and to prevent the kinds of lock-in that hampered the last generation of policy innovations. But as the rigidities of the forest products and ICT sectors show, action can be blinding. In today's uncertain world, even the best institutions cannot avoid mistakes. They can, however, respond to them quickly. Building such institutions is the challenge for Finnish innovation policy on the cusp of a new era (Sabel, Saxenian, 2008, p. 122).

Finland appears to have certain structural challenges. Reactions to them may have been hampered because, according to many indicators, Finland was, until recently, doing well in its traditional strongholds. Now there is both a need and an opportunity to make a clear break with the past (Veugelers, 2009, p. 6).

The imbalance of innovation activities is greater in Finland than in any other of the EU15 countries. Finnish companies are more one-sided in their focus on cutting costs and often concentrate on extending the life cycle of existing products and services rather than renewing them. For years, the innovation of products and services in Finland has relied too strongly on the largest companies and the ICT sector (Alasoini et al., 2014, p. 7).

The activeness of Finnish companies in producing *new products and services* in the 2010s has been notably lower than in Denmark, which stands out clearly from other European "innovation leaders" such as Finland, Sweden, and Germany (Alasoini et al., 2014, p. 15).

There is anecdotal evidence that, due to information asymmetries, vested interests, or poor alignment with corporate or R&D strategy, R&D projects become loose ends with little immediate impact on the path of the enterprise. There are propositions that often (publicly funded) R&D projects in large enterprises grow out of the interest and drive of individuals. This leads to added value only if the results are integrated into new product development and/or spin-off activity. Reportedly, Tekes-funded projects have contributed relatively little to spin-offs or entrepreneurship. Reflecting these findings, we must recognize that the data for the analysis are from the period before the present strategy, which was launched 2011 (Viljamaa et al., 2014, p. 82).

Finland's telecommunications industry, and Nokia benefited directly from the establishment of Tekes. Tekes funds alone accounted for an average 8 percent of Nokia's total R&D expenditures between 1980 and 1995. Many of the largest Tekes projects in these years were tailored to Nokia's needs, including the development of the digital call center system, GSM technology, and software tools and protocols (Sabel, Saxenian, 2008, p. 65).

Tekes's total funding for R&D projects, for example, increased 30% between 1998 and 2007, from €361m to €469m, while the number of projects it financed steadily decreased. Tekes reports that it financed 2,454 projects in 1998 and only 2,120 projects in 2007. The average project size thus grew 50% in less than a decade: from €147,106 in 1998 to €221,226 in 2007. It appears that Tekes, which in the 1980s and 1990s provided a flexible source of funding for collaboration and experimentation by researchers in public and private institutions, has become increasingly powerful, but also less relevant to local industrial innovation (Sabel, Saxenian, 2008, 113).

A direct connection cannot, however, be drawn between Tekes's efforts and the economic performance of Finland. At best, Tekes can create some of the conditions necessary for success. The world is, however, changing rapidly and constantly. International challenges, at some points aggravated by national circumstances, require more attention to the renewal of the industrial base, focusing on companies able to excel in international markets. Tekes has taken these developments into account in its new strategy, aiming at renewal of sectors and at supporting start-up and high growth companies operating internationally. The new strategy seems to encompass a sensible shift in portfolio, taking more risk but without making a complete break from the past. Important points for improvement are Tekes's support for internationalization, its relation with other agencies in Finland, including regional representation, and the role of Tekes in public debate (van der Veen et al., 2012, p. 37).

Observations from the field

After the financial crisis, the Finnish economy has, in general terms, went through a quite considerable restructuring. In real terms the Finnish GDP is still below its 2008 level and the country's near-term prospects are bleak. The development of the Finnish GDP in this millennium is depicted in Appendix 4. The structure of the Finnish economy has seen a reduction in the role of manufacturing, and increase in services, which, in 2014, accounted for more than 70 % of the GDP compared to 60 % in the beginning of the century. Still, as Finland is a country dependent on imports for raw material and energy, the export is of great significance.

In the aftermath of the financial crisis the exports have suffered even more than the GDP: diving from €87 billion in 2008 to only €64 billion the following year and levelling out at about €77 billion for the years 2011-2015 (see Appendix 4). Here, the impact of Nokia, and the telecommunications sector, is particularly notable. Its share of exports amounted to €9 billion in 2008 and, in 2015, its share had decreased to less than €700 m.

The rapid changes facing the Finnish economy have formed an unprecedented turbulence in the environment of Tekes over the last ten years. Despite the decline of export volumes and GDP share of manufacturing, the Tekes

funding for the manufacturing sector has remained quite stable. Four sectors accounted for 89% of total Tekes funding during 2004-2015. These sectors were (i) manufacturing; (ii) ICT; (iii) professional, scientific, and technical activities; and (iv) education (see Appendix 5).

Conclusions

The meta-analysis confirms the view that Finland needs to rethink its national innovation system. However, there have been diverging opinions about how to read the external signals. Sabel and Saxenian noticed that Nokia had, by 2000, "outgrown" Finland and started to withdraw from local collaborations and began to emphasize intellectual property protection and trade secrets (Sabel, Saxenian, 2008, p. 15). One year later, however, evaluators of the Finnish innovation system suggested that the significant role of Nokia in the Finnish innovation system was not any concern, as such (Veugelers, 2009, p. 121).

Tekes has been an integrated part of the symbiotic, public-private innovation system in Finland. When Nokia was successful it was difficult to know to what extent the success in the innovation system was dependent on Nokia or not. Now, that Nokia no longer has the same impact on the outcomes of the innovation system, there is an increased need to establish a new way to deal with the increasingly complex challenges facing the Finnish innovation environment.

The tradition of the Finnish innovation system has been for a close symbiosis between the public innovation actors and the private sector. Historically, this collaboration worked out well. But as Sabel and Saxenian (2008) indicated, in the new millennium Nokia and other large corporations increasingly began to focus on cost cutting and the relative importance of Finland was reduced in their international strategy. When the SHOK regime was introduced the room to maneuver for Tekes was further reduced, which impacted the way Tekes could allocate funds to other areas.

Finland has been hit by several external shocks at the same time: Nokia's reduced presence, the financial crisis, the restricted trade with Russia, and the diminishing emphasis on Finland by the large Finnish corporations. Tekes has here been somewhat handicapped due to the reduction of Tekes's budget and the pre-allocation of a substantial part of that budget to the SHOKs until 2015. There is a recently observed rise in interest towards Finland from three different perspectives. Firstly, the Finnish gaming cluster in combination with the start-up community has clearly increased international interest in Finland as an innovation environment. Secondly, the availability of highly skilled engineers due to the reduction of staff in Nokia has attracted global companies like Intel and Huawei to Finland. Thirdly, there is an increased interest from other Chinese companies and investors to come to Finland as well. All these new signs of interest in Finland have been supported by Tekes, even if one could question if the efforts have been big enough.

A 2009 evaluation of the Finnish national innovation system stated that there appeared to be a common and widespread view in Finland that its citizens did not have a particularly entrepreneurial culture. Further, and critically, can Finnish attitudes be made more accepting of—and ambitious for—greater entrepreneurial activity? Here a positive development has taken place, for which also Tekes can share some of the credit.

The evaluation of Tekes in 2012 recommended Tekes to take a more active role in public debate. This is an area which could still be improved and particularly the way Tekes is active internationally.

For each of the evaluation questions we will identify the strengths (S) of Tekes in matching the requirements of an attractive innovation environment. We will also identify potential (P) through which Tekes could, in future, make an even stronger contribution to improving the attractiveness of the Finnish innovation environment.

S1. Start-up support. ***Tekes has actively supported the strengthening of the start-up culture in Finland.***

P1. Strategy & direction. ***Tekes should, in future, take a more active role in the public debate.***

P2. Internationalization. ***Tekes needs to even more actively support the internationalization of Finnish SMEs.***

How has the steering in the Finnish innovation environment progressed, and what has been the role of Tekes in this?

Meta-analysis

Under the leadership of the Prime Minister's Office and in cooperation between ministries, operating models will be created for managing wide-ranging policy development actions that extend to several branches of administration. This model will be exploited in the implementation of the strategy for leading growth sectors (Research and Innovation Council, 2014, p. 21).

Overall, the basic task for Tekes has been the renewal of firms and industries, rather than productivity growth in existing firms—although long-term productivity growth is also important at the micro level. Although productivity may be the most important indicator of competitiveness, the other targets may be easier to grasp (Viljamaa et al., 2014, p. 42). The econometric analysis examines the causal effect of public R&D subsidy on firm productivity. After controlling the selection bias, it can be concluded that five years after receiving Tekes funding, the productivity of funded firms does not significantly differ from that of the control group. The results of estimations should be interpreted with the

caution. There are multiple limitations to this study that can affect the final conclusions (Viljamaa et al., 2014, p. 74).

R&I policy must interact with a number of other sectors, including economic, labor, transport, environmental and regional policy, as well as social welfare and health care. Promoting innovation is up to all ministries and branches of administration. Implementation of social development projects across the boundaries of administrative branches will challenge the current management models, structures, and expertise. At the level of the Government and branches of administration, steering that sees the links between various issues and phenomena is needed (Research and Innovation Council, 2014, p. 27).

Collaboration between the Academy of Finland and Tekes could be more strategic, focused on a better, combined research and innovation policy for Finland and a joint approach to international collaboration (van der Veen et al., 2012, p. 33). Tekes and the Academy now separately develop Finnish international collaboration, which is scattered and subcritical. There is clearly a need to have more joint research programs, Finland needs better combined research and innovation policy, as is more common in other Nordic countries (van der Veen et al., 2012, p. 96).

Tekes should realize more strategic and operational cooperation with other national Finnish agencies. Especially others tasks that Tekes is performing for the Ministry, or other Ministries than TEM, should be prioritized and managed better than at present. Tekes and the Finnish ministries could consider dedicated R&D collaboration schemes with regions outside Europe in priority fields that fit well with Finnish national priorities (van der Veen et al., 2012, p. 136).

There is a strong reason for keeping Finnvera and Tekes separate: namely that it is unhealthy to have the same organization fund both the development and the commercialization of the same technology. A more open and strategic cooperation between Tekes and Finpro, including Invest in Finland, would benefit both parties, in addition to being of importance for Finnish companies. The cooperation with Sitra could be on a more strategic level and a more structured communication and strategic cooperation may increase impact (van der Veen et al., 2012, p. 33).

The list of requirements resulting from this study shows that the concept of "broad-based innovation" seems to be a suitable fit with the expectations of the Finnish innovation sector. This must be provided through a strong national collaboration involving different public agencies as well as the private sector. This also, increasingly, demands international support. This poses significant challenges for Tekes. On one hand, Tekes is often expected to take the intellectual lead when political decisions must be made for the future direction of Finnish research policy. However, at the same time, Tekes should be a neutral financer, following the innovation policy guidelines provided by the government (Wallin et al., 2012, p. 72).

Tekes no longer has its previously unassailable position in public debate. The very defensive, almost cramped, reaction of Tekes to recent criticism has weakened its image. Its interventions are questioned in political and public debate. A rally in opposition to Tekes has even been organized. In order to reverse this negative atmosphere, Tekes must refocus its communications and become more proactive, not reactive. This does not only mean communication of efforts and effects, but an intensive open participation in public discussion. Tekes should, once again, be a leader in public debate, as a facilitator giving broad platform to contributions from all parts of society, including high quality contributions form its own organization (van der Veen et al., 2012, p. 37).

We welcome the basic ambition of the broad-based innovation policy. It provides a balance between the supply and demand sides of innovative activity, includes nontechnical innovations, as well as emphasizing—alongside direct economic impact—wider societal considerations. Conceptually, the new, broad-based innovation policy is, however, fuzzy, thus, making it important that the government soon provides clear contents to the concept so as not to let it dissipate. The Finnish system does not have a strong systems-wide coordination. The lack of involvement of the Ministry of Finance and less active involvement of the Prime Minister's Office in coordinating research and innovation policy formulations is a drawback. There are significant overlaps in the services offered by public organizations. Streamlining is urgently needed (Veugelers, 2009, p. 11).

The challenges of growth and competitiveness can no longer be tackled only by means of a sector-based, technology-oriented strategy. Instead, a demand-based innovation policy must be strengthened alongside a supply-based innovation policy (Veugelers, 2009, p. 20). We endorse their experimentation with innovation promotion in a demand-based mode. We recommend that the resources devoted to the SHOK initiative be limited to enable the support policies for the development of new product groups in new sectoral systems of innovation. We recommend that the international dimension be more strongly aligned with the new SHOK programs and their procedures (Veugelers, 2009, p. 32).

According to our understanding, the hoped-for reforms in the sectoral research system have largely failed because they affect strong vested interests in ministries and public research organizations. Lacking political will, the reforms will not be forthcoming. A structural reform in sectoral research could become a show-case for the new, broad-based innovation strategy. However, unless the government can implement the reform, it faces a risk of losing credibility in its commitment to the implementation of the new innovation strategy. The extent of the necessary reform obviously represents too radical a change to be implemented quickly and can realistically be expected to be put in practice only over a longer period (Veugelers, 2009, p. 35).

The computing and internet worlds, into which the mobile phone industry is quickly being absorbed, is more open, more competitive, and faster-paced: barriers to entry are low and innovation can come from almost anywhere, including even the smallest firms. The challenge is no longer to simply design new features or technologies into a device; the challenge is to design complete solutions that integrate the hardware, software, and services to meet customers' needs. This requires changing internal processes and culture, altering relationships with operators and customers, and redefining partnerships with both private and public sector collaborators (Sabel, Saxenian, p. 103). It is clear that a continued focus on process improvements is a dead-end strategy in a global market characterized by overcapacity and the rise of aggressive new competitors in developing countries with far lower costs (Sabel, Saxenian, p. 111).

Observations from the field

The 30 biggest customers for Tekes's funding in 2004-2015 received about 45 % of all the funding (see Appendix 5). The largest customers are VTT, the largest universities, as well as leading manufacturing corporations (Nokia, Tellabs, UPM, Stora Enso, Kemira, Neste, Borealis, Metso, Valmet, Wärtsilä, ABB, KONE, Orion). A significant amount of the money allocated to large companies is reallocated to ecosystem partners. Tekes funded large companies' RDI project with EUR 124 million in 2014. Of this 86 per cent, or EUR 106 million, was channeled through subcontracting to SMEs or research service purchases or research funding to higher education institutions and research organizations (Tekes, 2015, p. 25).

Conclusions

Sabel and Saxenian's comments in 2008 (p. 87) were very insightful at the time, stating that they did not have a great deal of confidence that Finnish industry would respond with sure-footed ease to the multiple challenges it faced. They had, to their surprise, encountered forms of instructional lock-in where they expected to find openness and fluidity. They had not found promising anticipatory changes, neither at the level of (re)-organization, nor at the level of (re)-conceptualization of strategy as embodied in a series of concrete projects—as opposed to merely being imagined as a series of power point slides. The closed organizational model that had allowed Nokia to remain the lowest-cost producer of mobile devices had significantly constrained its ability to innovate along alternative technological pathways. Finnish policymakers appeared similarly blinded by their past successes (Sabel, Saxenian, 2008, p. 112). The transformation called for is now gradually taking place, but considering the overall economic situation in Finland, the pace has been relatively slow. This can also be seen from the surprisingly steady financial contributions over the period 2004-2013 for the largest organizations being financed by Tekes. The last two years have displayed more dynamism.

This cognitive lock-in characterized the Finnish innovation system for quite a while and it could be argued that it took too long a time until some more fundamental changes became visible. Here, Tekes has lately shown signs it is taking a more determined lead, e.g. in the set-up of the collaboration with IBM regarding the Watson Health Center and in actively promoting new forms of urban transport.

However, as suggested in several reports over the past years, Tekes is expected to be a more active participant in the public debate on innovation policy in Finland and show the direction. In this respect, the visibility of Tekes has been relatively low-key. This needs to be addressed. Also missing are efforts to more actively support demand-based policies. We will return to this when discussing resource allocation for prioritized areas.

The strengths and potential for Tekes can be summarized as follows.

S2. Health sector. ***Tekes has been actively driving innovation collaboration in the health sector, collaborating with large international companies such as GE Healthcare and IBM.***

P3. Collaboration. ***Tekes could more actively drive the collaboration across various public sector actors in the Finnish innovation system also outside the realm of Team Finland interacting with several sectors such as economic, labor, transport, environmental and regional policy, Academy of Finland, as well as social welfare and health care.***

P4. Market co-creation. ***Tekes should strengthen demand-based innovation policies alongside its supply-based innovation policies.***

P5. Productivity. ***Tekes should more actively seek prioritized areas that also offer enhanced productivity and value capturing opportunities for the Finnish economy.***

How has prioritization in the Finnish innovation environment been carried out, and what has Tekes's role been here?

Meta-analysis

The recession and structural change have challenged Finland to seek sources of new growth. A small country with its limited resources can only aim for the highest global expertise in few and relatively narrow fields. We must specialize and make choices, which must be based on existing strengths and competitive advantages as well as bold initiatives in R&I activities and policy. New sources of growth must be found. A precondition for success in international competition is specialization, choices made together by the public and the private sector alongside operating models, incentives, and foresight that support them. The choices

will focus on areas of strength and discernible signs of growth (Research and Innovation Council, 2014, p. 10).

The greatest impacts on our society and economy will be caused by digitalization, climate change, and change of the natural environment. The future competitive advantages (bioeconomy, cleantech, digitalization, and the health sector) will be reinforced by joint and better-coordinated actions of the administrative branches. This will take the form of large development projects that require a systemic operating method. R&I policy measures will be implemented together with other key policy sectors. The possibility of promoting emerging growth initiatives must be kept open all the time (Research and Innovation Council, 2014, p. 21).

The health sector growth strategy is a new initiative prepared by three ministries, Tekes and the Academy of Finland. The strategy responds to the competence needs of the health sector. A precondition for achieving global high-class expertise will be an extensive and interactive network of many actors, or an ecosystem. Typical features of such networks are close public-private partnerships, jointly identified targets, and strong interdependence between actors. The more extensive the network is, the more important role the public sector will have in promoting the functioning of the ecosystem (Research and Innovation Council, 2014, p. 20).

An observation from the Danish innovation system is that it favors a broad concept based on a wide set of policies including social policy, labor market policy, education policy, industrial policy, energy policy, environmental policy, and science and technology policy. Such a national innovation system then calls for national development strategies with co-ordination across these policy areas (Wallin et al., 2012, p. 22).

Small countries in general neither can, nor should, set the same ambitions for domestic innovation as the United States or China. Critical to the performance of small countries is the capability to learn. This requires skilled labor, good labor relationships, and good collaboration with customers and among experts with different backgrounds. Having made this basic assumption, Lundvall concludes that the Finnish innovation strategy is the one that comes closest to combining the DUI and the STI mode, forming a systemic understanding of what drives innovation and of how innovation is transformed into economic performance. This observation is based on the explicit strategy formulation of the 2008 Proposal for Finland's National Innovation strategy (Lundvall, 2008, p. 5; Wallin et al., 2012, p. 22).

With its activities, Tekes has contributed to the cooperation between companies and knowledge infrastructures, which for Finland are important areas and, in this way, helped to build knowledge and competences to support the international competitiveness of Finnish companies. The changes in strategy were visible. Tekes budgets going to large companies has been heavily reduced, while funding for start-ups and growth companies strongly increased, with new funding rules and mechanisms (van der Veen et al., 2012, p. 130).

Tekes has increased funding to young growth companies in recent years. The growth figures of these companies and their good rating, in comparison, to other companies shows that Tekes has picked the best companies and projects to fund from a large group. In 2013, Tekes funded young, innovative companies seeking rapid growth with €28 million. About 16 % of this went to companies in the Vigo accelerator program. Funding has since 2008 covered a total of 247 companies, receiving a total of €158 million from Tekes. In 2014, Tekes funded young companies, those less than six years old, with €127 million (Tekes, 2015, p. 22).

There is no indication that countries with high frequencies of start-ups perform better in terms of innovation and growth than those with low frequencies of start-ups. One reason for this may be the fact that most innovation processes are interactive and take place within or across the borders of existing organizations. What may be more important than individual entrepreneurship is 'collective entrepreneurship'. In Denmark, the main challenge, despite a wealth of start-ups, is the scarcity of high growth firms. Scaling up is therefore a key word used by several of the innovation agencies (Wallin et al., 2012, p. 42).

Tekes's individual support for larger companies seems, although heavily criticized, a good way to connect research organizations and smaller companies to sector leaders and, thereby, give them connection to international markets. In a broader sense, the Finnish system is not producing enough breakthrough innovations or commercial results. There are concerns that Tekes lacks the skills and procedures to optimally support the start and growth of a business enterprises, but, as of late, Tekes is perceived to be offering more of the right incentives to stimulate commercial success (van der Veen et al., 2012, p. 130).

The Finnish economy is dominated by a few large, multinational enterprises (MNEs), many of which have specialized on production where large size, low costs, and high capital intensity define the competitive edge. This specialization is suboptimal for a small, high wage country, located at the economic and geographic periphery of Europe where demand is at least quantitatively satisfied and future growth is expected to take place in high quality products and niche-markets respectively. A country like Finland should specialize more in industries where complex solutions and the capability to respond to consumers' or investors' demands define the competitive edge. Existing firms in developed, high wage countries should specialize in product innovation, adding features and services to the product. The leading Finnish firms have moved considerably in this direction, but the SMEs are lagging behind (Veugelers, 2009, p. 115).

The Finnish innovation system suffers from a mismatch between 1) the growing demand by Finnish High Growth Entrepreneurial Firms for global insight, foreign expertise, international networks, and 2) an insufficient supply of inward foreign spillovers due to the scarcity of world class human capital, foreign R&D, and cross-border venture capital within Finland's borders. Even if there is no single policy measure that can resolve this issue, it should be urgently recognized and addressed (Veugelers, 2009, p. 147).

Global insight, foreign expertise, and global networks should be present and accessible in the innovation system at the time the opportunity is recognized. Given the global dimensions of many key markets, the question then becomes who could and should introduce such a foreign (non-Finnish) perspective or provide global reach and information? In short, the generic question is: how can an ambitious, skilled, and growth-oriented entrepreneur acquire critical market information whenever it is in his/her interests to do so? Thus, the challenge for Finland is to attract strong and multifaceted linkages to foreign talent that, *by its very presence*, would help accelerate and deepen the international understanding and perspective of participants in the Finnish innovation system (Veugelers, 2009, p. 172).

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. 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 (Halme et al., 2015, p. 60).

In an increasingly globalized world a national innovation policy requires coherent integration for the country to be internationally attractive for top experts and venture capital. The Finnish government needs to take this into consideration when forming an integrated national innovation and industrial policy. The innovation policy should simultaneously emphasize firm-level and network-level activities as well as making certain that the institutional factors supporting an entrepreneurial climate and forming innovation-friendly tax policies are also taken into consideration (Wallin et al., 2012, p. 72).

Observations from the field

The conceptual foundation presented in the first part of this report integrated two streams of research: policy making and strategic management. The findings suggested that there is a need to consider the characteristics of the specific business sector when trying to define what constitutes an attractive innovation environment at a particular point of time. We concluded that an attractive innovation environment consists of a combination of three supportive elements: resource provision, market co-creation, and capability building. How these elements interact depends on the nature of the business sector, and the position the companies globally enjoy in the sector. When considering how such integrated measures have been undertaken we want to understand how Tekes has executed its most visible responsibility: allocating funding to individual enterprises. We will do this by analyzing the four major business sectors supported by Tekes: (i) manufacturing, (ii) ICT, (iii) professional, scientific, and technical services, and (iv) education.

During the 12-year period 2004-2015 the manufacturing sector has received a total of €1513 million, or in average €126 million per year. There are three main industries among the thirty biggest manufacturing customers:

- Information and communications technology (Nokia, Tellabs, Teleste, EpiCrystals, Ericsson, and Cassidian),
- Pulp and paper (UPM-Kymmene, Stora Enso, and Metsäliitto), and
- Mechanical engineering (Wärtsilä, Metso Automation, Metso Paper, KONE, ABB, Rautaruukki, Sandvik, Outotec, Metso Power, Cargotec, Vacon, Metso Minerals, and STX Finland).

In addition, there are four chemical companies: Kemira, Neste Oil, Borealis Polymers, and Chempolis; one pharmaceutical company (Orion); Philips, which in Finland has a significant medical devices R&D unit belonging to the Philips Healthcare division; Valio, which is the biggest dairy company in Finland; and Vaisala, which is a leading technology company in environmental and industrial measurement.

The 30 biggest customers have received about 40 % of the total Tekes financing to the manufacturing sector during the observed period. The main manufacturing sectors also provided the foundation for the Strategic Centers for Science, Technology, and Innovation, SHOKs: information and communication technology (Digile), mechanical engineering (FIMECC), and pulp and paper (FIBIC).

A second major category of organizations financed by Tekes has been professional, scientific, and technical services. During the period 2004-2015 this category has received €1391 million or an average of €116 million per year. In this category, the single biggest financed organization has been the state-owned research institute, VTT, which together with the European Space Agency (ESA) represents over 50 % of the funding registered in this category. The remaining organizations basically represent two categories, public research organizations devoted to some specific research sector or commercial companies focusing on research activities. The second category includes biotechnology or medical research companies (FIT Biotech, Biotie Therapies, Horos Medical, Bioactive Bone Substitutes, Nexstim, FibroGen Europe and Ipsat Therapies).

A third category among Tekes's focus segments is information and communication services. During the observed period, this segment received financing amounting to €726 million, or an average of €60 million per year. In this category, we see the greatest amount of dynamism in the funding (see Appendix 5). The thirty biggest customers represented only about 22 % of the funding to the category. One can identify four sub-segments in this category:

- Commercial software applications (Elektrobit, F-Secure, Exfo, Multi Touch, Tieto, CSC, ZenRobotics, Napa, Rightware, Mirasys, Digia, Stonesoft, Ixonos, and Verto Analytics),
- Mobile solutions (Telia Sonera, Jolla, Aava Mobile, NetHawk, Codenomicon, Ekahau, Enevo, Mobisoft, and Capricode),
- Health technologies (Medicel, Mawell), and
- Games (Remedy Entertainment, Grand Cru).

The fourth category getting substantial support from Tekes is the educational sector: universities and polytechnics, which over the period got funding amounting to €1453 million, or an average of €121 million per year. The financing to the educational sector has primarily been allocated to the leading Finnish universities, representing over 90 % of the financing to this category with Aalto University, University of Helsinki, University of Oulu, Lappeenranta University of Technology, and Tampere University of Technology being the main recipients. The composition of the funding to the educational sector varies across the universities. However, the university sector is the one which has faced the largest decline in funding, from over €170 million in 2011 to less than €120 million in 2015.

Conclusions

Public funding for R&D at companies is quite low in Finland by international comparison. Most of the public funding goes to universities and research organizations. Cooperation between universities, universities of applied sciences, research institutes, and companies creates expertise that accumulates corporate innovation activities in Finland. Large companies play a key role, because research and the networking of SMEs with large companies create competitive advantages—global challenges require large companies to play their part and network with SMEs (Tekes, 2015, p.11).

What our analysis of the four biggest categories of Tekes customer segments reveals is that the single biggest segment being financed 2004-2015 has been the manufacturing sector (€1513 million), followed by the university sector (€1453 million), research organizations (€1381 million), and ICT services (€ 726 million). As can be seen from the tables, the manufacturing sector has kept its funding level surprisingly well (in average €126 million per year), despite the overall decrease in Tekes funding and the reduced impact of the manufacturing sector in the Finnish economy. Funding to the university sector has been much more erratic, amounting to €171 million in the peak year 2011 and being reduced to €117 million in 2015. The research sector is dominated by VTT, which has also seen its financing reduced lately, from €58 million in 2013 to €39 million in 2015, being almost the same as the combined financing to the two major recipients of university funding, Aalto University and the Tampere University of Technology. ICT services is the most dynamic of the four segments analyzed, with the top 30 customers only representing 22% of the overall financing in this group. However, we need to remember that the biggest ICT-related companies (Nokia, Tellabs, Teleste, EpiCrystals, Ericsson, and Cassidian) are categorized as manufacturing companies. However, this segment is half of the average size of the three other main customer segments.

Also worth noting is that a recent impact study has recognized that it is difficult to collate precise data on funding per priority area (bioeconomy, cleantech, digitalization, and the health sector). This is partly because priority areas do not correspond directly with industrial classifications (used to segment firms), but it also reflects the significant overlap between bioeconomy and cleantech projects and synergies between health and digital (Reid et al., 2016, p. 17). We would therefore strongly recommend that Tekes and Team Finland more precisely define the specific focus areas and objectives of the innovation funding.

The need for more precise definitions throughout the Finnish national innovation system would help to align and create stronger focus among the actors, which would be a way to increase the attractiveness of the Finnish innovation environments.

Two major observations can be made based upon the meta-analysis. The first one is the increased importance of start-ups as catalysts for change. Here, Tekes has been supporting the positive development through increased financing to start-ups. However, as the meta-analysis suggests, and as a recent report for Slush 2016 by PwC verifies, the dynamics of the interplay between start-ups and large corporations needs to be better understood and supported in a more sophisticated way by the Finnish national innovation system. We will return to this when discussing the allocation of government resources to prioritized innovation areas in the next section.

The other observation relates to the need for a stronger international interaction between the Finnish innovation environment and the outside world. This requires more coordinated efforts across all relevant actors in the Finnish innovation system. We strongly recommend Tekes be more active in this area in the future, as many evaluations and impact studies have seen international networking as the Achilles heel of the Finnish national innovation system.

The European Commission notes, in its 2016 country report on Finland, that new companies are not as internationally oriented nor as innovative as their peers in other Member States. As a small, open economy, Finland's integration into global value chains is crucial and requires its companies to look outwards. In addition, better use could be made of research results to generate new products and services. (European Commission, 2016, p. 3) We will discuss this aspect in more detail in the next section.

S3. Financing and administration. ***Tekes has been able to efficiently adapt to new requirements regarding its processes and offerings, including new funding rules and mechanisms, when the external conditions have changed.***

P6. Ecosystem nurturing. ***As ecosystems are increasingly the source of innovation and competitiveness Tekes should further increase its efforts to support the formation of international ecosystems in selected competence areas where Finland has some distinctive comparative advantage.***

In addition, ***we can note that internationalization (P2) and collaboration (P3) are emphasized in this section.***

How have government resources been allocated for prioritized innovation areas and what role has Tekes played here?

Meta-analysis

The public sector will take on a new role as an active promoter and exploiter of innovations. In addition to horizontal, inter-administrative development measures, this will require changes in the practices, statutes, and competence of public actors. The innovation system must provide incentives for new initiatives, experiments, innovations, and (growth) entrepreneurship. The structure of business life will be diversified and continuous renewal of companies will be supported. The capital market for start-ups and growth enterprises will be boosted by public measures (Research and Innovation Council, 2014, p. 6).

The ministries that play a key role in R&I will, together with public funding and support organizations, create measures, operating methods, and flexible structures for making choices together regarding R&D. The key principle of innovation funding will be the promotion of the functioning of ecosystems in the current leading growth sectors and the creation of new sources of growth. The public sector will ensure that the basic preconditions of an operating environment are in place and guarantee a favorable setting for new R&I initiatives and new growth. The public sector will also speed up innovation activities, create demand for innovations, and support market and business development. By creating an intelligent demand for innovations, we can reform public services, create a strong innovation incentive for actors and provide references for efficient solutions (Research and Innovation Council, 2014, p. 21-24).

Key methods of supporting and increasing demand for innovations will include R&I friendly public procurements, taxation, regulation, and standardization. The policy tools for demand must be developed across administrative boundaries and policy domains, in a determined manner and more extensively than today. The total value of public procurements is considerable, amounting to some €35 billion a year. If only 2–3 per cent were spent on procuring innovative solutions, this would provide a significant additional incentive for companies and complement public support for R&I. Public procurements can help to guide companies towards participating in the development of new solutions to social problems and deploying new operating methods and technologies. Procurements will also serve as a strategic tool for the public sector in developing public services. Sectors suited for testing procurements that encourage R&I activities include energy, the environment, wellbeing services, and infrastructure (for example: communication, transport, and construction). To use public procurements to create innovations, stronger incentives are needed. The target is that public actors will spend at minimum 3% of their procurement budgets on procurements that represent new solutions in the market. Clear instructions for applying statutes will be drawn up for innovative procurements (Research and Innovation Council, 2014, p. 25).

In industries, such as health care and education, public institutions are among the most important customer segments, in which public agencies can serve as important pilot customers in the demonstration phase. The public agency can also be a provider of some central capabilities within the ecosystem (Wallin et al., 2012, p. 20).

In global cooperation, we must be active and work with the best available partners. Intensive exploitation of knowledge and expertise produced abroad is necessary—there is no such thing as a purely national operating environment. Internationalization will be promoted as a part of all innovation system and R&I sector development. Incentives must be created that support this aim. Finland must be internationally attractive and provide incentives for R&I and entrepreneurship (Research and Innovation Council, 2014, p. 12).

The main impact of Tekes is not on the short-term (turnover, exports, etc.) growth of individual 'client firms' but rather through the triggering and/or 'nurturing', over a longer run period, the emergence of new, technology-based 'ecosystems' that help restructure 'traditional' sectors or develop new high-value-added activities. Tekes is viewed as less effective in fostering collaboration or value chains linkages both nationally and, particularly, internationally. The ecosystem cases underlined the significant role of larger or leading, 'anchor companies' in the creation of ecosystems and their evolution. At the same time, 'incumbent'

larger firms (e.g. in biofuels) may be both critical for the development of new value chains and 'slow' to shift towards the new business models (e.g. due to cost of adapting to new processes, etc.). The quality of interaction between such large or lead firms in ecosystems and smaller/start-up companies can be critical. The specific obstacles differ, but common themes included access to international market intelligence, regulatory differences/ approval (e.g. self-care, smart grids), early integration/ positioning in global value chains, or securing opportunities for piloting or testing products or 'platforms' in foreign markets. A key lesson from the study is that achieving global competitiveness calls on the various business ecosystems to develop tailored and diverse forms of support that often stretch beyond the remit and resources of Tekes alone (Reid et al., 2016, p. 27).

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 (Halme et al., 2015, p. 55).

In relation to "innovation activity in a world without frontiers", NIS stresses the need to participate and influence international networks. According to NIS, the success of enterprises and regions depends on their ability to position themselves in global networks. Positioning requires the active participation of Finnish experts that can provide added value to partners based on their state-of-the-art competences. We strongly argue that the best way to increase the participation of Finnish academics in the international community and to attract foreign experts to Finland is to reward universities for the quality of research (Veugelers, 2009, p. 242).

Concerning the internationalization of enterprises, Tekes funding supports networking nationally for enterprises that are inclined to do so. However, Tekes R&D grant terms and conditions do not enforce networking. In one case, in direct comparison with the EU FP7, Tekes funding had a less direct impact on international networking or internationalization (Viljamaa et al., 2014, p. 58).

A novel approach to internationalization is attracting foreign companies to invest in R&D in Finland. The tool used here is the 'tentative funding decision'. Thus, if a foreign firm considers investing in Finland and Invest in Finland identifies them, they can have a discussion with Tekes before their decision, Tekes can give them a tentative decision for R&D funding. This is the Finnish answer to what happens in many other countries, i.e. the 'a priori' promise of tax reductions (van der Veen et al., 2012, p. 113).

The 'mainstreaming' of the internationalization throughout Tekes's organization, with Tekes advisors allocating a small part of their time explicitly to promote international R&D cooperation, means that the dedicated advice on international S&T collaboration has become spread too thinly in the Tekes organization. While some outside Tekes have suggested a more active 'matchmaking' role of Tekes representatives abroad, in our view, the provision of 'matchmaking' functions goes beyond the scope of Tekes's role (van der Veen et al., 2012, p. 35).

We may conclude that the role of Tekes in producing societal impacts strongly relates to Tekes ability to create networks, add relevant partners to project consortiums and to enable the usage of relevant outside resources. This suggests that Tekes has impacted firm behavior (Behavioral additionality) through its intervention and created positive changes in how networks are created. This behavioral additionality appears to be positively linked with generation of societal impacts (Valovirta et al., 2014, p. 10).

Financial support alone is generally not enough to realize fast growth and important societal impacts. Tekes's market pull support, especially in the semi-public markets of environment and wellbeing, could be important. Supporting public procurement of innovation is becoming an established approach. Sophisticated use of other forms of demand-side innovation policies (regulation, standards) are still in a nascent stage. Within the cases analyzed, only one innovation had a rather direct route to existing markets with well-articulated user needs (Valio). In other cases, the market for innovative product did not exist but it had to shape up before diffusion was possible, thus delaying generation of impacts. For environmental innovations, the key driver for new market creation has been introduction of new or tighter regulation. For wellbeing, it was not possible to identify any single key driver for market emergence. The dynamics appear to be rather different for consumer demand (e.g. food with health claims), regulated demand (pharmaceuticals), or institutional demand (public and private health and social care services) (Valovirta et al., 2014, p. 12).

The single most important innovation support activity raised in the survey was the need to establish constellation platforms bringing together actors from different sectors for open innovation. This implies that, besides the need for Tekes to proactively promote a broad innovation policy agenda in Finland, Tekes itself must also increase its support of different forms of networks and provide platforms that will enable more efficient collaboration. Of particular importance is the question of how the knowledge management activities can be supported by an innovation agency like Tekes. The three phases of exploration, demonstration, and exploitation need, therefore, to receive attention when Tekes increases its support of innovation in networks (Wallin et al., 2012, p. 72).

In 'demand driven' innovation, Tekes's role should focus on industry and helping industry to create business. In public sector innovation support for R&D, promoting interaction between regulators, forerunners, and users and demand-side measures like experiments, creation of lead markets, and procurement are important support options

that contribute to the development of new products and services. On the demand side, Tekes can only play a role when the problem owner(s) on the government's side have a clear goal that can be explained to industry. In cases where goals are not clear (e.g. at present in health care policy) it is the task of the problem owning ministry to set clear goals first, only thereafter can Tekes play a role on the demand side (van der Veen et al., 2012, p. 33).

The new Tekes strategy—focusing on companies that operate internationally—might increase the tension between ELY centers and Tekes, because this strategy reduces the number of companies in the Tekes target group and, therefore, also the number of regional companies in the target group, The already very small units of Tekes people in ELY centers in some regions will then become even smaller and will often be subcritical, not able to provide the support that Tekes wants to offer its customers (critical mass is estimated at 10-15 persons per Tekes unit) (van der Veen et al., 2012, p. 105).

There seems to be a clear need to clarify the roles between public organizations supporting innovation and businesses (Tekes, Finnvera, Finpro, etc.) and to ensure effective signposting between them. Further mergers within the Finnish innovation support system would further focus the attention on internal processes at the agencies, instead of focusing on serving customers. TEM should implement within its agency system (including the ELY centers) a cooperation structure, consisting of a clear division of tasks, a comprehensive customer segmentation, good mutual knowledge of each other's' support instruments, and an effective way of signposting to each other (van der Veen et al., 2012, p. 108-109).

Tekes has interfaces with many organizations in the system. On these interfaces, there is often good operational cooperation but there seems to be good opportunities for strategic and operational synergies that are presently not exploited. Tekes should be more open to these opportunities and should develop far more open and strategic relations with other agencies in the Finnish system (van der Veen et al., 2012, p. 109).

An important pillar of internationalization is formed by the activities of Tekes to improve the interaction of Finnish stakeholders with international multilateral collaboration platforms. It is a general problem that FP7 has failed to attract industry and SMEs. The support for participation in European Technology Platforms is provided through National Contact Points (NCPs) which in practice consists of a network of individuals of which the majority work part-time on EU matters (typically 5-10 % of their time). Tekes advisors receive no formal training for understanding how the Brussels machine works. The ELY centers mostly consider the national funding as 'low hanging fruit' so why bother going through the bureaucratic hoops of an EU application (van der Veen et al., 2012, p. 114)?

Observations from the field

Case BioMediTech

The emerging human spare parts industry draws on high-quality scientific research. The experiences of the institutional home of Tampere-centric regenerative medicine, the University of Tampere, in technology transfer and commercialization are almost non-existent and hence the related competencies are poorly developed. The need to reach international markets and funding sources is well understood at BioMediTech, but it seems to be clear that the strategic awareness about emerging global markets is still poorly developed and shared generic competencies in the ecosystem to exploit emerging opportunities are not systematically constructed. The Tampere University Hospital has not carried out any major strategic efforts to establish regenerative medicine in its standard repertoire, nor has it proactively constructed the required competencies. Based on our interviews, the university hospital is not likely to adopt a more strategic approach soon if there is no significant pressure either from the society at large (in practice the public health care policy) or from abundant individual medical doctors. There is also a need to make the collaboration with the Finnish hospitals more programmatic to gain first-user references close to home and ensure that the benefits of the science in question are available in the country that has funded the research (Sotarauta et al, 2016, pp. 36-37).

Pushing a new field through several systems and related policies calls for such navigational competencies that are not usually readily available at the universities, and this again highlights the need to bring into focus the generic competencies embedded in the entire ecosystem instead of only one organization. Legitimization is about attaining social acceptance of innovation; therefore, ultimately, it is about making an innovation comply with the predominant institutions (norms, values, habits, and regulations) and/or addressing the need to transform institutions for something new to emerge. Legitimization is one of the most central selection mechanisms in any innovation system. Based on our interviews and other data, it seems to be clear that leadership that would work for the entire ecosystem has not yet emerged, and the focus is still on the scientific core and a few selected measures and networks (Sotarauta et al, 2016, p. 39).

Conclusions

The main finding from both the meta-analysis and the case of BioMediTech is that there is a need for increased attention to demand-side innovation policies. How to better support the co-creation of ecosystems and markets is a major challenge in the Finnish innovation system, and the single most important factor that could improve the attractive-

ness of Finnish innovation environments. The suggestions of this report to use Strategic Innovation Initiatives also with the public sector as a main customer segment, such as Social and health care systems and Urban transport would provide concrete cases to speed up the development and capability building in this area. This also emphasizes the need for horizontal activities, where Tekes should take a more active role in engaging other actors in the Finnish innovation ecosystem, but increasingly also abroad. For example, the establishing of the Watson Health center by IBM in Finland should be accompanied by a clear, global strategy for Finland to leverage upon the international network of IBM to ensure that results from demonstrations and pilots in Finland can rapidly be disseminated internationally and enable increasing exports of the participating companies. How to do this in such a way that value can be captured for Finland should be the responsibility of Tekes. This concern has been identified by the Research and Innovation Council, which observes that a major part of the added value from R&D carried out in Finland will drain out of the country. However, part of the financial gain from R&D will return to Finland through multinationals' internal transfer pricing. Providing an attractive operating environment, thus, is a significant factor in ensuring that the value of new goods produced in Finland remains in the country, even if many of the company's branches were located abroad (Research and Innovation Council, 2014, p. 23).

When considering the demand side efforts, we agree with the observations of the report by Veuglers et al (2009) stating that crowd-sourcing, open innovation, and some other recent buzzwords may well be important issues in organizing innovative activity, but having others provide effort for less than its full value or accessing the existing knowledge pools more extensively are not innovations *per se*. With the Internet and related developments, the possibilities to *organize* innovative activities have expanded enormously and technology might also help one to uncover unarticulated user needs. While engaging, these facts should not be over-emphasized (Veugelers, 2009, p. 98). This should be remembered when considering how to relate technology development to innovation policy, e.g. digital services and the Internet of Things, among other things.

One evaluation report observes that there are capabilities particular to networks, like trust and collaboration between independent organizations. This report portrays a network illustration with Tekes, large enterprises, research organizations, and SMEs as indicated participants (Halme et al., 2015, p. 61). What is striking is that in this illustration there are no other public sector organizations included. This also illustrates that the prevailing implicit approach when considering the role of Tekes is how Tekes relates to companies and research organizations, not how Tekes relates to other public sector organizations in Finland and abroad. Here there is a need for a rapid re-orientation in the mindset within Tekes, and within the Finnish innovation system. Otherwise we cannot genuinely establish attractive innovation environments in Finland. Even if the statement is that Team Finland actors should agree on cooperation and division of work, for example in terms of internationalization capabilities and growth funding (Tekes, 2015, p. 22). However, it is the second part of the sentence that dominates: when working together each actor could focus on its own strengths.

This also raises the issue of governance principles within the Finnish innovation system. This issue was addressed also when discussing the SHOKs, when it was concluded that despite the relevance of the original goals, there were concerns that one of the key goals (excellence) was, in effect, compromised from the beginning. The evaluation recommended that the SHOKs should have introduced thematic cross-SHOK programs addressing key topics of societal relevance (e.g. smart city, economic efficiency, preventive health, digital solutions for wellbeing, etc.) (Lähteenmäki-Smith et al., 2013, p. 14). The suggestion of this report to introduce Strategic Innovation Initiatives follows this recommendation.

Having seen the rapid reconfiguration of the ICT sector due to Nokia altered strategy makes the observations by Sabel and Saxenian, regarding the effects of a possible loss of leadership in a business sector, relevant. They suggested that the loss of leadership would not completely devalue the skills and prowess that Finns have worked so hard to accumulate. Suitably reconfigured, one could expect that Finnish firms could redeploy the skills they contain to produce applications or subsystems for the new platform leaders. Indeed, Sabel and Saxenian speculated that a period of collaborative "followership" of this kind could be an expeditious, perhaps even necessary step towards regaining leadership — or discovering that in today's world of co-design and co-production the difference between leading and following is itself fugitive (Sabel, Saxenian, 2008, p. 104). The case examples Aava Mobile, GE Healthcare, Huawei, Intel, and Zalando indicate that this process of reconfiguration is now going on. How Tekes can further support this restructuring is of utmost importance when aiming at making Finnish innovation environments more attractive. This also emphasizes a new perspective on the international aspects of innovation policy. It is not primarily about stimulating exports, but about inserting Finnish companies into international networks. This can, and should be supported, by the public innovation actors through the establishing of global pipelines connecting critical sites in Finland with relevant peers across the globe. These sites however need to be selected based upon the competence area in question. Key sites for health technologies are different compared to e.g. automotive. Therefore, the selection of Strategic Innovation Initiatives is a prerequisite to identify which would be the

most important foreign locations that should be targeted for more intensified international collaboration involving companies, universities, research institutes and other public sector actors depending on the competence area.

Finally, we need to raise one aspect related to innovation dynamics which lately has received scant attention in the innovation discussion. This is the fact that cities are active and increasingly important innovation policy actors. The Research and Innovation Council has noticed that cities' investments in the future, including transport, energy and land-use projects, must be utilized as platforms for developing innovations (Research and Innovation Council, 2014, p. 22). An earlier evaluation report showed how Oulu has been a case where once some critical requirements were established, the evolution of the industry in the region was dependent on the existence of strong individuals that provided the means to attract additional individuals sharing the common objective of making the region competitive in the cluster. (Wallin et al., 2012, p. 16) As the INKA-program was abandoned it is important that Tekes also in the future will be able to integrate developments in cities into the strategy for how to support innovation environments. The selection of Adaptive manufacturing ecosystems as a potential Strategic Innovation Initiatives is based on the observations that the two intended anchor companies, Meyer Turku, and Valmet Automotive, have very clear regional anchoring outside the capital region.

When considering the role of Tekes in the prioritization of innovation policies in Finland, it is further confirmed that Tekes has an important role in influencing decision making on collaboration within the public sector (P3), internationalization (P2), market co-creation (P4), and ecosystem nurturing (P6), particularly when inserting Finnish companies into global networks.

How has governmental capability building taken place in the Finnish innovation environment, and what has Tekes's role been here?

Meta-analysis

Continuous change is a cross-cutting and permanent state of society and the economy. We need better capabilities for operating in dynamic environments. Change is continuously opening up new opportunities, which must be exploited as an incentive for renewal and a driving force for R&I (Research and Innovation Council, 2014, p. 10).

Resilient economies show strategic adaptation rather than pure, more passive, adaptation. Strategic adaptation refers to the sensitivity to various changes and the capacity to adapt to them, but at the same time it stresses the ability to create collective perceptions of each phase of evolution as well as its own 'story of development' and its support. Strategic adaptation calls for a well-established set of integrated competencies and asks for generative leadership. Generative leadership is needed for (a) the creation of conditions to nurture and stimulate innovation and business growth (culturing capability), (b) the facilitation of the adaptation of an entire ecosystem to a changing environment (sensing capability), (c) the construction of collective intentions and strategies to enhance the productivity of an innovation ecosystem (seizing capability) and (d) the generation of new processes that improve and change competence sets or bring new elements of them into existence (configuring capability) (Sotarauta et al, 2016, pp. 31-34, parentheses added by the authors of this report).

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; Halme et al., 2015, p. 12).

Our methodological approach in this assessment of Tekes's 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). There is a need to systematize the use of capability as a concept in future studies regarding monitoring and impact evaluation. Tekes has its own definition, which could be further elaborated and clarified. Emphasis should be paid particularly on the building of dynamic capabilities (Halme et al., 2015, pp. 14-16).

The recommendations of the capability impact study: (i) refining the concept and objectives of innovation capability building for the specific purposes of Tekes, (ii) Tekes should undertake a separate analysis of the capability needs and support mechanisms for SMEs, (iii) focusing on the areas and means, through which Tekes has a clear added value, (iv) emphasis on system level capability building, with the focus on economic renewal, (v) development of continuous monitoring, measurement and indicators for to support capabilities for innovation activities, and (vi) Tekes funding for R&I institutions, especially for universities, is cru-

cial for enhancing the commercialization of research results (Halme et al., 2015, p. 64).

The impact study recommends that Tekes should focus on the individuals and the organizational capabilities needed to build and foster international networks, as international networks are becoming the main form for successful innovations. Tekes should also place emphasis on ensuring that dynamic and orchestration capabilities are properly built in the ecosystems and that funding also supports the inclusion of necessary international elements (Wallin et al., 2012, p. 44-51).

Supported by the Government, the ministries will work together to select clearly-defined, goal-oriented development projects that will be implemented using experimentation and through shared responsibilities, implementation, steering and evaluation. Doing things together, developing operating methods and wide exploitation of good practices will be accelerated by means of test projects. In 2015, the ministries will draw up concise reports on innovation activities in their branches of administration and the related development and cooperation needs. These reports will contribute to formulating a joint view of the status of innovation activities, and in the forthcoming government term, extensive cross-administrative and systemic development projects will be implemented in a coordinated manner and by combining resources, at first focusing on a few themes of high social importance (Research and Innovation Council, 2014, p. 27).

All international cases have shown that a clear ownership structure, reporting duties and accountabilities are pre-requisites for an effective governance. Networks should report to the funding agencies monitoring data on a regular basis, including a pre-defined set of indicators and measures. The responsible funding organizations set the rules of the game and ensure that data gathering standards are maintained. Independence of a certain number of members of the governance board also seems to be a pre-requisite for ensuring self-control and steering. Furthermore, clear intervals for interim assessments, which make use of self-assessment procedures and external peers are also important for making programs alike work. Program management needs to have strong capacities to be able to closely monitor the implementation process of activities and changes thereof. Network programs need to put a lot of efforts on measurement 'while projects are ongoing'. Responsibilities should be shared between program management, network organizations, and external evaluators (Lähteenmäki-Smith et al., 2013, p. 308).

The present governance structure gives Tekes freedom to determine their strategy but requires formal approval of the strategy by the Ministry of Economic Affairs and Employment (MEE). Furthermore, a quite target-oriented performance agreement is concluded between the MEE and Tekes every year based on Tekes annual working plans. Compared to many other agencies, in Finland as well as abroad, Tekes has much freedom of operation, In the last few years, governance has tightened to some extent but the implementation of Finnish innovation policy is still, to a large extent, determined by Tekes. Tekes and the MEE representatives are satisfied with the way the governance is organized. Tekes should therefore remain the innovation agency for the Finnish government and major changes to Tekes governance are not necessary (van der Veen et al., 2012, p. 133).

The focus of Tekes has gradually shifted. The balance between strategic research, for the long-term renewal of Finnish firms and the Finnish firm base, and the shorter-term R&D addressing more immediate company needs, should be guarded (van der Veen et al., 2012, p. 134).

We may judge that the administrative procedures and structures in public research institutes lack innovative organizational solutions. A reform of sectoral research started in April 2005 when the government made the decision to implement structural reforms in the public research system. A committee led by Yrjö Neuvo, appointed in December 2005, in its report a year later, suggested several quite radical measures. Neuvo's committee made an important recommendation to improve the competencies within ministries to commission sectoral research and to strengthen horizontal co-operation across ministries in this matter (Veugelers, 2009, p. 34).

We recommend a multi-year reform plan concerning the steps to be taken to implement the reforms. We further recommend the dedication of significant resources to the renewed Advisory Board to strengthen its capacity to implement horizontal research programs to satisfy the information needs. The two major research funding organizations, Tekes and the Academy of Finland, could help and provide lacking research contractor and proposal evaluation skills. Last, but not the least, to facilitate a structural reform, the long-term goal of the reform should be reorganization of the public-sector research institutes into a small number of groups according to broad societal questions, and not according to the present administrative sectors (Veugelers, 2009, p. 35).

The panel acknowledges that Finland is too small a country to support many truly world-leading science- and technology-based innovation centers. It also maintains that from the point of view of the new – broad-based – innovation policy, Finland should simultaneously promote the development of national spearheads and enhance learning capabilities for continuous renewal in the society as a whole. By doing so, it will attempt to create a fertile soil for unexpected new developments to emerge all over Finland, and not only in a few pre-selected centres (Veugelers, 2009, p. 41).

The above-mentioned recommendations would create a division of labor between programs that aim: (i) to renew existing strong sectors of the Finnish economy and boost

their innovation activity on national level, (ii) to develop innovation awareness and innovation systems explicitly for public service provision and non-science-based clusters on local/regional level, and (iii) to create new possibilities for experimentation and exploration of something totally new and thus to prepare the ground for unexpected innovations to emerge. Of course, there ought to be coordination among these three spheres of innovation policy (Veugelers, 2009, p. 44).

The relevant public policy agencies in Finland have not – as a collective of public organizations—been able to identify the *problems* that should be solved by means of the innovation policy. Neither have they had the *ability* to solve or mitigate those problems. Accordingly, the conditions that constitute the rationales for public policy intervention have not been fulfilled. To develop such a broad-based innovation policy, the following elements are necessary:

1. The *problems* to be solved by means of public innovation policy should be identified through analysis. These problems entail the objectives sought by the innovation policy goals, but that private organizations are unwilling or unable to achieve.
2. The main causes of these problems should be identified.
3. The state (national, regional, local) and its public agencies should have the *ability* to solve or mitigate the problems. This means that the state must design the various instruments needed (Veugelers, 2009, p. 55).

For an innovation agency, the ambition is to be able to promote the development of each set of capabilities forming the intellectual capital. This then requires that one examines the mechanisms through which capabilities are developed and, consequently, identifies policy actions that can promote their development (Wallin et al., 2012, p. 13).

How successful a region will be in an ecosystem is dependent not only on its internal relations, but also on the way the region connects itself to larger pipelines through a subset of nodes. This requires a coalition of key actors working in the regional context to co-align their forces based on a grounded and converging vision of the region's strategic identity and mission (Normann, 2001, p. 307). This calls for a high quality strategic process based on horizontal interactivity, future-oriented processes to evolve a vision of strategic identity, the skill and ability to utilize events and various assets and processes to bring people together in creating a new 'social reality' with action implications (Normann, ibid. p. 311; Wallin et al., 2012, p. 22).

Given the predictable failures of the institutional responses to the predictable danger of disruption, the attention of decision makers and theoreticians is on finding ways of training emotions and senses to heighten awareness of the danger – maintaining a constant alert so as reduce the time needed to respond once a threat does materialize. But surely organizations can be, and are increasingly designed to encourage this kind of alertness, even if no organizational response in itself guarantees it, however, we found that the struggle against inertia has been harder than we or many others would have expected or desired (Sabel, Saxenian, p. 25).

A precondition for supporting emerging sectors and technologies and the early recognition of weak signals is developing a joint operating model for continuous follow-up, new operating methods and a solid knowledge base (Research and Innovation Council, 2014, p. 20). Companies and the public sector will be encouraged to develop management skills, practices and processes by which the employees' skills can be optimally used in terms of innovation and productivity. Management training and competence related to intangible capital will be strengthened (Research and Innovation Council, 2014, p. 23).

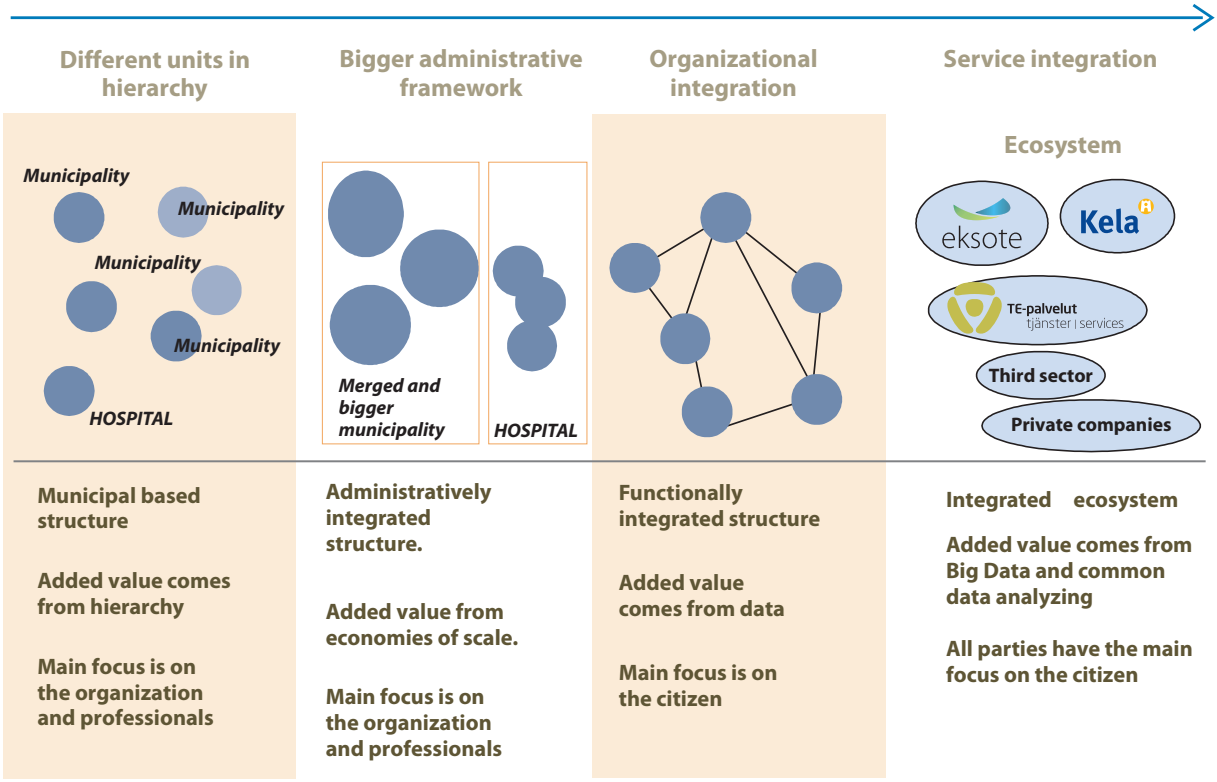
Observations from the field

Case Eksote

Governmental capability building in the public sector is not solely restricted to national actors. In the social and health sectors, the responsibility is, first and foremost, on the regional level. One actor that has received increased attention, both domestically and internationally, thanks to its innovativeness, is Eksote, the South Karelia Social and Health District. Eksote, responsible for all public social and healthcare provision in the South Karelia region, has been a forerunner in adopting digitalization and forming new types of service systems. Eksote aims to integrate acute hospital care, primary care, and social services, including elderly care. This is managed in one regional organizational structure where added value comes from a more efficient use of common data based on integrated ICT systems. Kinnula et al. (2015) have estimated that if all Finnish social and healthcare districts could achieve the efficiency of Eksote, the annual national cost savings would amount to, at least, €1.5 billion. Eksote believes digitalization will challenge the functional design of hospitals, emergency response, and the role of home care and expert nursing. By investing in new digital services and the citizens' own care and personal measuring and monitoring, substantial efficiency improvements can be achieved while also improving customer care (Itkonen, 2016).

Eksote's ambition is to utilize digitalization to enable entirely new services, new roles for professionals, and new kind of partnerships with the citizens. Exceeding beyond simply digitalizing the existing care chains or working faster. This implies that only those patients truly benefiting from hospital care go to the hospital. This will result in large cost savings, and reduce the required hospital capacity (i.e. elimination of waste). To achieve this, local authori-

Figure 6. The evolution of the business model of Eksote (Itkonen, 2016).



ties, private companies, and third sector organizations must continuously learn how to improve their collaboration and actively seek new roles and partnership models in prevention and social and healthcare promotion. Such capability building also requires active participation form the national level. The evolution of Eksote's business model is depicted in the above figure (Figure 6).

Eksote knows that the field of health will see one of its most disruptive periods in the forthcoming years and decades. Putting more financial resources into the health systems does not necessarily enhance health on a population-wide level. Healthcare systems face problems that relate to present health policies. Management practices and knowledge management procedures ought to provide contested information about the ways of performing better and more efficiently, in terms of citizen-driven wellbeing models aiming at a systemic change in the field of health. Achieving this calls for a more profound understanding of the potential of knowledge management in this new information driven, citizen-centric world of health (Wallin et al., 2017).

To be even more effective, Eksote needs to orchestrate the integrated ecosystem and bring added value from Big Data and common data. Digitalization enables improved visibility into the costs of the system to make informed choices. One can investigate whether investing in preventive care will avoid higher treatment costs at later points in the ecosystem. This calls for closer linkages between preventive healthcare and primary and secondary care as well as integrated treatment pathways for suffers of a given condition or disease. Establishing such an innovation ecosystem cannot be achieved in an individual social and health care district without national support. The citizen-centric approach calls for new architected service models, including the engagement of the citizens themselves, public health and social care organizations, and companies. There is also a need for the active participation of the research community to verify the results (Itkonen, personal communication with the authors, 2.11.2016).

Conclusions

Tekes has stated that its ambition is to be the enabler in the Finnish innovation ecosystem to create vibrant business into Finland and contribute to the building the world's greatest innovation environment. Internationalizing, growth-seeking SMEs form Tekes's key target group (Tekes, 2015, p.15).

Historically, Tekes has had the capacity to provide the foresight capabilities essential to initiating necessary new initiatives in the Finnish innovation system. In a previous evaluation, it was argued that Tekes should strongly support the forming of the agenda, define the guidelines for how to bring various actors together, and co-orchestrate

the collaboration within the knowledge community building the next generation of the Finnish innovation system (Wallin et al., 2012, p. 72). The innovation policy and Team Finland discussions during autumn 2016 in the Finnish Government show that there is understanding for the need to drive the changes that have been identified in many of those reports and evaluations that have been referred to in this meta-analysis. It could also be argued that, investment from Tekes, in capability and community building, has postponed the reconfiguring of the Finnish innovation system and has led to the Ministry of Economic Affairs and Employment's decision to reconsider Team Finland's strategy. As Tekes has had a relatively autonomous position in the Finnish innovation system, it could have addressed these issues at an earlier stage on its own initiative. The first signals in this direction were in the Sabel and Saxeninan report in 2008, and, as this meta-analysis has shown, the same message has been repeated several times after that.

The previous government had already declared that for monitoring purposes, the ministries, public R&I funding organisations, and other specifically named actors would report to the Research and Innovation Council on their actions relevant to the development recommendations by the set deadline. The first reports were to be requested in autumn 2015 (Research and Innovation Council, 2014, p. 33). The ambition was that the Council would then have evaluated the reports and made a statement about the further measures it would have found necessary, considering, among other things, the programme of the new Government to be formed after the parliamentary elections in April 2015. As the elections resulted in a different political set-up these plans didn't materialize. This doesn't however mean that the need has disappeared. On the contrary. It is therefore encouraging that measures were in autumn 2016 taken by the present Government to overhaul the activities of Team Finland. Team Finland's operations will be reorganized in two stages. First, measures that can be implemented within a short timeframe will be carried out. Next, the Team Finland working group will assess the potential for structural reforms that the Government will decide upon in its mid-term review in April 2017. The ambition is to address identified problems with Team Finland, such as an ambiguous and excessively broadly defined service promise, a muddled and multi-tiered management system and the fragmented structure of the business services. Moreover, cooperation between the various actors is not working as well as it should.

In line with the findings of this impact study, it has been decided that the international resources of Team Finland will be strengthened, and that the embassies will be in a key role here. The piloting of establishing collaboration with the Chambers of Commerce in Germany is also in line with the ecosystem approach advocated in this report. One concern is that the focus will, once again, shift to internal organizational politicking, taking away the focus from the real business concerns. Also, the involvement of the Academy of Finland and the university sector would be paramount in mobilizing the collective efforts of the Finnish innovation system to strengthen its international impact and support economic growth.

We strongly recommend using the idea of Strategic Innovation Initiatives as a catalyst for action learning and to establish a way of working driven by business facts and not driven by organizational and political ambitions. The Japanese example of strongly involving external experts, recognized in their own fields, provides a good benchmark. This would provide all involved parties with the real-world connection to the various types of requirements that attractive innovation environments expose, once we go beyond the surface of the general ideas about networking, international pipelines, spearhead competencies, potential of digitalization, ecosystems and capability building. On the surface, all innovation environments share these properties. But if we compare what is required for world class performance in Social and healthcare systems or in Adaptive manufacturing ecosystems these elements of the innovation environment look quite different on the detailed level, as is the interaction between the elements, their maturity, and the relevant global nodes that should be engaged if we want to create an attractive Finnish innovation environment, properly interconnected through global pipelines.

The request for in-depth business and industrial insights to facilitate these kinds of analyses and dialogues with various external stakeholders is a task that naturally would belong to Tekes, which already is the actor in the Finnish national innovation system which has a continuous dialogue with the most prominent commercial actors in the system. We must remember that addressing the immediate need to improve the operational efficiency of Team Finland should not hide the more fundamental issue of how the Finnish innovation system will be able to carry out the three core tasks of identifying and promoting its strengths (in a continuously changing context), inserting companies in global networks (which will require collaboration between start-ups, SMEs, large companies, and universities and research institutes), and building governmental capability. **The root cause of the present difficulties is the underdeveloped governmental capability.** This should be kept in mind when entering the next phase of transformation. Numerous evaluations and reports have addressed this issue, and we only here want to once more re-emphasize that strengthening the dynamic capabilities of the Finnish national innovation system should be prioritized when moving forward. The way the roles and responsibilities could be defined will be reverted to in the third part of this impact study.

S4. Ordinary capabilities. ***Tekes has the capacity to be the innovation agency for the Finnish government and major changes to Tekes operational governance are not necessary.***

P7. Dynamic capabilities. ***The present turbulence in the world economy calls for stronger dynamic capabilities from Finland and its innovation system actors. Tekes should here take the lead and facilitate the formation of knowledge alliances with trusted international experts to strengthen the dynamic capabilities of the Finnish innovation system.***

P8. Feedback/learning. ***The meta-analysis of this report has shown that many of those issues that are now addressed by the Team Finland working group have been identified in previous impact studies and reports. Tekes should ensure that there are processes in place to continuously evaluate how feedback and lessons-learned are implemented.***

What are the best tools and overall possibilities for Tekes to achieve the highest impact on the Finnish innovation environment?

Meta-analysis

Eliasson's competence bloc theory focuses on the minimum set of actors with the competencies needed for an effective innovation ecosystem and business growth. According to Eliasson (2000), the purpose of a competence bloc "is to guide the selection of successful innovations through its competence filter, induced by incentives and enforced by competition, and to move the innovations as fast as possible towards industrial scale production and distribution". The quality of a competence bloc is to be measured by its outputs and not its inputs, that is, "through a bundle of functionally related products and services in the market but not in terms of technologies or physical inputs" (Eliasson, 2000). Consequently, a competence bloc is geared to select winning technical and economic solutions and not to measure the inputs required to achieve them. The emphasis on selection aims to minimize two errors: (a) allowing losers to survive for too long and (b) rejecting potential winners. Importantly, a well-functioning competence bloc also attracts competent investors and other actors who contribute positively to the dynamism of an ecosystem; conversely, those whose contribution is not as positive are ruled out (Sotarauta et al, 2016, p. 32).

The competence set is an assembly of generic competencies that, in conjunction, generate new knowledge and secure its diffusion and valorization in the society and economy. Needed here are s a set of competencies that not only enhances the emergence of new knowledge but also links it to business growth, economic renewal, and/or societal change. Subsequently, there is a continuous need to upgrade individual competencies and refine the entire competence set to adapt to the changing environment. Additionally, an innovation ecosystem as a whole, or some of its competencies, may not be at an adequate level. Missing and/or poor competencies may freeze an innovation ecosystem and lock it into its past trajectory for these purposes (Sotarauta et al, 2016, p. 32).

The ecosystem case studies point to a number of areas where current levels of collaboration are still insufficient to fully support the development of emerging business models and ensure they gain access to new markets. There is a need to develop indicators that help track the extent to which value in relevant global value chains is captured in Finland, rather than focus on export growth, etc. Ecosystem success is measured, ultimately, by competitive differentiation (value proposition) and, hence, requires an additional qualitative understanding of the successful positioning of a significant number of Finnish firms in global value chains. This implies the need to establish a baseline mapping and regularly update the changing position of Team Finland client firms in global value chains (Reid et al., 2016, p. 30).

In the evaluation of public support for innovation, the additionality approach has commonly been utilized in recent years. As stated above, this approach has been the basis for Tekes's impact model. The additionality approach focuses on the impact that public R&D funding has on the project or the recipient organization (input additionality, output additionality, and behavioral additionality. Behavioral additionality (as well as output additionality) is not typically confined inside one firm but, rather, through various mechanisms spread across organizational boundaries. These "spillovers" may be considered key results (Viljamaa et al., 2014, p. 17).

Regarding the impact model, productivity is one of the main success measures set for Tekes. Although it is an important measure from the perspective of national economy and competitiveness, it seems that it is not as relevant (in the short term) to Tekes special interest groups. Young, fast-growing enterprises tend to invest most of their cash flow. Before R&D is completed to the extent that they have a product and/or service to the market, in some cases this phase is up to ten years, they create little added value. In addition, although productivity arguably measures the renewal of enterprises, a sustained increase in productivity demands keeping up with competition and, therefore, other measures better represent endogenous renewal. Possible measures to complement productivity include, for example, growth percentage of the enterprises, survival rate in different age cohorts, and measures of innovativeness, such as the number of spin-offs, new business areas and number of new (new-to-firm/network and new-to-market) and radical (new-to-network and new-to-the-world) innovations (Viljamaa et al., 2014, p. 81).

The results of the current impact assessment suggest that the impact model of Tekes is logical and follows from the basic mission, but is perhaps missing the underlying operationalization of the objectives to SMARTER indicators and elaboration of how the different instruments contribute to the objectives. The development of intervention logics and indicators alone would enable the collection of more focused monitoring data and thus sharpen program/instrument evaluation while making it easier and more inexpensive. Additionally, one of the main rationales for R&D funding, especially for large enterprises, is the supposed spillover to industry and society at large. Presently, Tekes monitoring at the project level does not capture data on the amount and nature of spillovers, other than the perception of spillovers from project managers through the ex-post self-evaluation questionnaire. When considering the results at a glance, it may seem that the average Tekes funding intervention has a relatively small impact on the productivity and renewal of the enterprise. However, a deeper analysis reveals that Tekes funding has a significant impact on productivity and, by extension, on the renewal of firms that are well positioned to use the outputs of the R&D funding. The averages also hide the great heterogeneity among innovation projects (Viljamaa et al., 2014, p. 81).

Funding will increasingly be allocated to large-scale, horizontal development projects and R&I aiming for long-term regeneration, rather than short-term measures or small-scale further development. The financing instruments of the Academy of Finland, the Strategic Research Council, and Tekes must be mutually complementary without overlapping. The funding organizations will work in closer cooperation. Due to changes in the volume, measures, and allocation of financing, the relevant ministries will review the mission and responsibilities of the funding organizations (Research and Innovation Council, 2014, p. 30).

Bridging the gap between exploration and exploitation demands a complex set of interactions and going back and forth among the various stakeholders, when seeking solutions that would qualify the innovation initiative to truly make a breakthrough and become a commercial success. This need for properly designed demonstration activities has become particularly emphasized when dealing with societal grand challenges (Pisano, Shih, 2009). These forms of innovation can be characterized as follows (Vinnova, 2011):

- They address essential or critical needs in society and industry. These needs require users/customers whose demand for solutions incentivizes them to engage in developing and testing new solutions. Co-creation is a critical success factor.
- They call for cross-sector collaborations to find solutions to the needs; solutions to social and societal challenges are rarely found in one traditional sector or in a single research field. New collaboration patterns are emerging between actors in different value chains; for example, 'green urban transportation' is being developed at the interface between energy, automotive engineering, and ICT.
- They foster systemic approaches which address different social subsystems, framework conditions, political, commercial, technological subsystems, etc. (Wallin et al., 2012, p. 22).

The rapid transition of the Finnish economy however suggests that there is also a need to deal with the other type of innovation process: orchestration. This calls for more horizontal activities, integrating different forms of technologies and encouraging combinatory knowledge flows, characterized by interactions that are extra-sectoral, non-systemic, and often involve unexpected combinations (Cooke et al, 2010). Such ecosystems are then characterized by the need for co-specialization, co-evolution, and asset orchestration (Teece, 2008) carried out by business *orchestrators* (Wallin et al., 2012, p. 22). While there are still very few pure orchestrating business models active in Finland, both our literature study and the case analyses confirm that orchestration support is an increasingly important form of innovation support that Tekes should integrate into its repertoire of innovation tools (Wallin et al., 2012, p. 64).

Tekes should make efforts to better understand the relative suitability of various instruments and tools in relation to different industries, network types, and firms in different stages of their development cycle. Especially when promoting innovation in networks, it is important to recognize that there are various forms of networks and their individual performance should be evaluated separately for each category (Wallin et al., 2012, p. 69).

Hence, the progress of technology becomes unpredictable, insofar as there can be no expectation that one good solution will lead by a natural progression to another. Counter intuitively, the more knowable the world as a whole becomes, the less confident we can be about the kind of knowledge that will prove useful in engaging its parts. By the same token, the more development depends on applying knowledge from domains traditionally unrelated to the industry's core activities, the less meaningful the idea of a technological frontier—it is everywhere and nowhere—and the less confident we can be that leadership today assures leadership tomorrow (Sabel, Saxenian, p. 17).

One reason for us to feel an obligation to provoke politicians and policy-makers to develop and implement "a broad-based innovation policy" is that the many interviews that we have conducted during this evaluation have indicated that the central policy-makers do not know about the details of the performance of the Finnish national system of innovation, i.e. the innovation intensities of various categories of innovations (propensities to innovate). No policy-maker presented, during the interviews, any data relating to innovation intensities for different categories of innovation

in the Finnish national system of innovation. It is obvious that there should be a more solid empirical evidence base to underpin policy formulation, thereby contributing to a better-defined policy (Veugelers, 2009, p. 54).

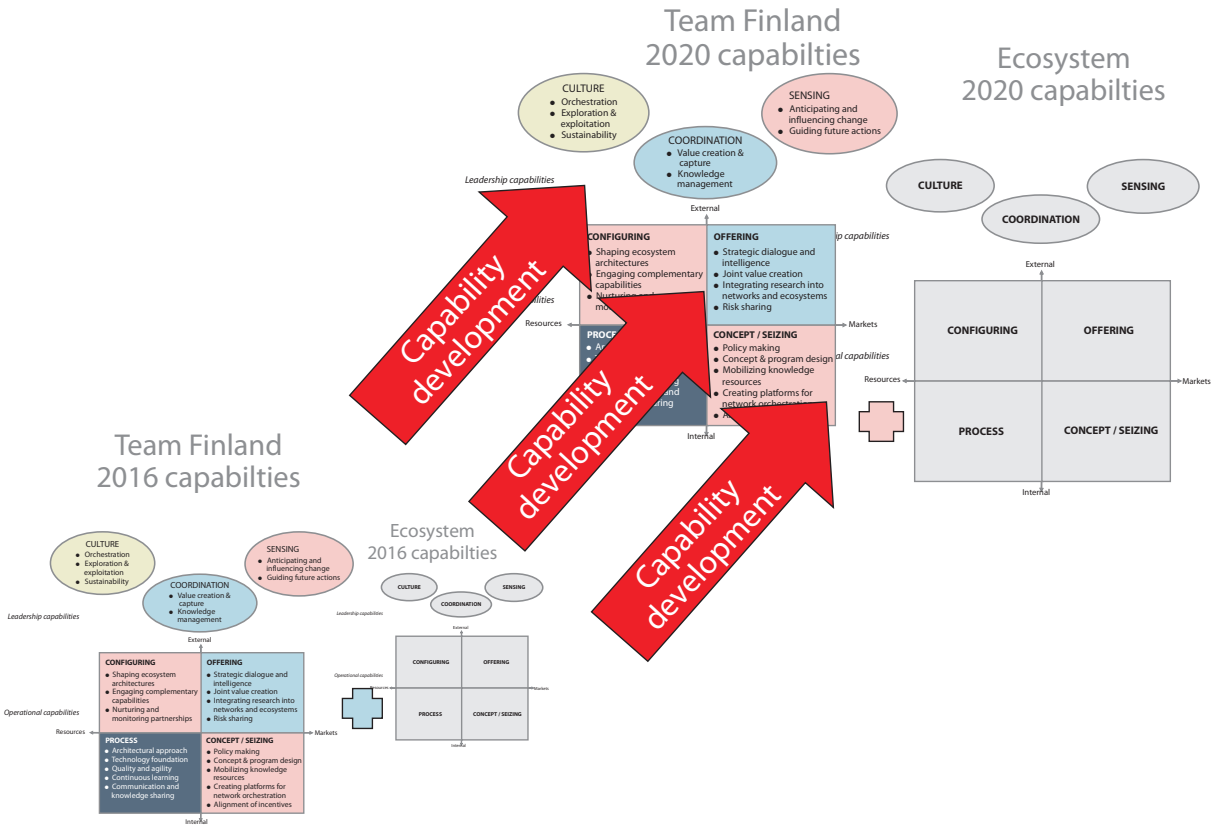
Research on Danish assisted-living centers for the elderly aptly illustrates the tacitness of needs. In seeking novel ways of managing these centers, researchers found that many of the user needs were *unarticulated*, that is, one could not discover the needs of the residents through an interview. Instead, researchers had to adopt a more *ethnography*- or *anthropology*- based research strategy, where they, instead of interviewing, observed the residents in the daily activities for extensive periods of time. Only from these in-depth, first-hand observations, researchers could draw conclusions about user needs, many of which were unarticulated. The requisite information on user needs was, at least initially, simply beyond words (cultural and social conventions) to describe them (Veugelers, 2009, p. 82).

Observations from the field

Capability building has emerged as a key activity across businesses and public sector actors. The here introduced capability map can be used as a tool when entering a more systemic capability building effort. Figure 7 illustrates how the capability building roadmap may be established.

The illustrative roadmap in Figure 7 indicates that, in the present situation, the Team Finland capabilities engage external capabilities to quite a limited extent. This is illustrated by the relatively small grey ecosystem capability map for 2016. The capability development activities will aim at strengthening both the capability base of the Team Finland actors and, even more so, to mobilizing considerably more capabilities from the broader ecosystem. This shift in how the ecosystem capabilities are mobilized is indicated by the color of the plus-sign between the two sets of capabilities. In the present way of working, the driver for engaging ecosystem capabilities comes from immediate customer demands for offering development, thus the connecting color is blue, indicating the link to the customer interaction capabilities. For 2020, the color is red and the capabilities of the ecosystem are seen in a broader context, strengthening the dynamic capabilities of Team Finland and, therefore, mobilized from a more strategic concept-development perspective. The notion of multiparty innovation is an interesting recent phrase which supports this type of reasoning (Furr et al., 2016).

Figure 7. A roadmap for capability building.



Conclusions

We have introduced three tools to support the evaluation of an innovation environment and to support the strengthening of an innovation environment. These tools are the Capability Map (Figure 2), the Excellence Framework (Figure 3), and the Orchestration Framework (Figure 4). These tools form the operational foundation of the Lean National Innovation System. Using these tools, we can summarize that the role of Tekes in the innovation system is to support the provision of a balanced contribution to three types of innovation activities:

- Support for entirely novel ideas and concepts that have the potential to become innovations with commercial success in the future ("stimulation of entrepreneurship").
- Encouragement of continuous improvement of the strongholds in the national innovations system to ensure that these competitive advantages will be maintained for the future as well ("resource strengthening").
- Guiding new venues for innovation and growth that often requires the co-creation of new markets, ecosystems and clusters ("market co-creation").

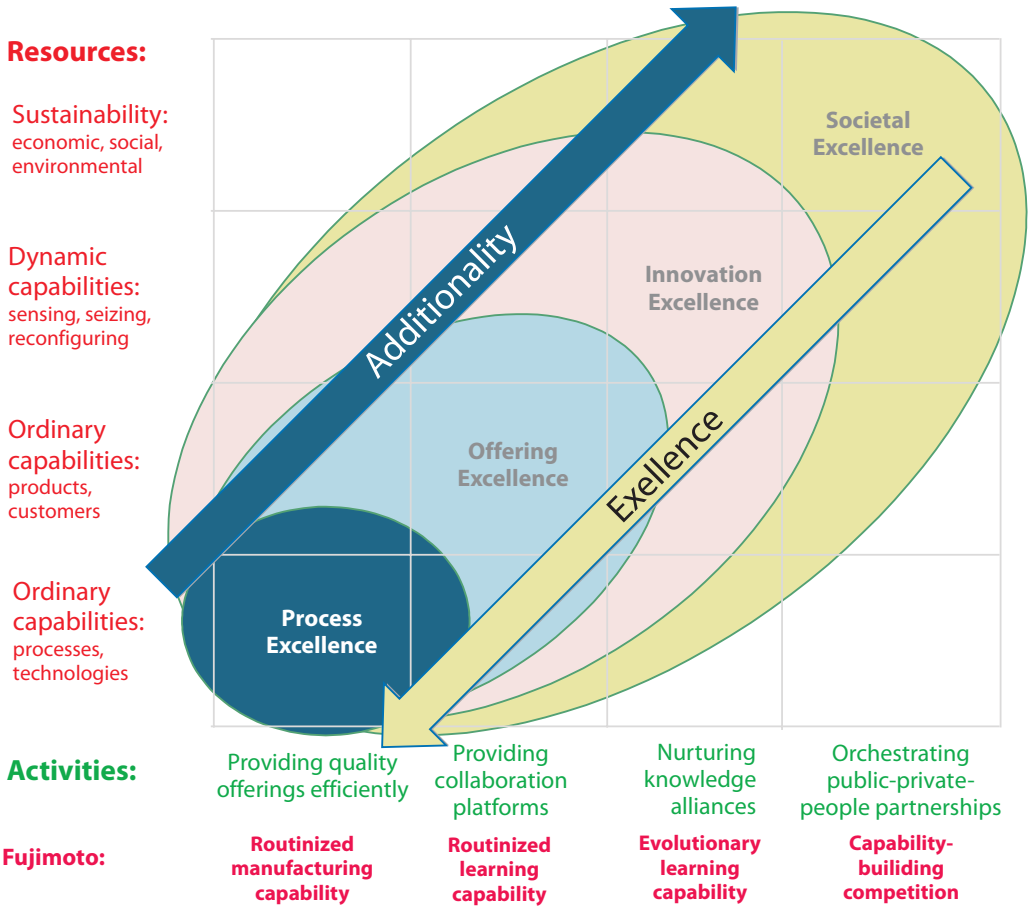
From a systems perspective, we can observe that there are now two major trends prevailing in the Finnish innovation system: resources for research and support to startups and SMEs. Historically, the main drivers of the Finnish innovation system have been the strong collaboration between industry and academia, which, in practice, has allocated a large part of the resources to the continuous incremental improvement of existing industries. This was also recognized as a weakness of the SHOK program. In reaction to this development, we can now see a preoccupation with fostering startups and venture activities, which are expected to lead to the emergence of new success stories. However, as the literature review of this impact study has shown, the start-up field is not producing results in the same way as before. Startups have found it harder to get off the ground, contributing to a decline in the number of startups in America, lower now than at any time since the late 1970s, and more companies dying than are born (Wooldridge, 2016). This suggests that governments and innovation agencies must increase their efforts to provide more support for the co-creation of new markets, ecosystems, and clusters, which will leverage upon the strongholds that the country possesses.

We suggest that governments should take a stronger position in the guiding and monitoring of the innovation activities they support. The frameworks presented here can be used as tools for this guiding and monitoring. The first question to ask is how excellence will be defined in the future in a specific area of business, what is the relative importance of process, offering, innovation, and societal excellence? Secondly, one must identify how the orchestration mechanism will work. Will there be natural ways for orchestrators to emerge from the private sector? Or will it be necessary for the government to establish a new body that will take responsibility of orchestration? Or is there a need to initiate "collective impact" efforts (Kramer, Pfitzer, 2016) to enable proper orchestration? Thirdly, how will the capability building activities be carried through and how can the government secure that proper knowledge sharing processes will be in place, without prohibiting key participants from maintaining their rights to proprietary knowledge? Finally, new solutions for the issue of gain-sharing are called for when the society takes a major role in the innovation process. By more actively nurturing, coordinating, and monitoring its portfolio of innovation activities, the government should also be able to more effectively gain feedback and learn. Thereby, also strengthening the governmental capability of the government and its agencies. These principles form the basis of a Lean National Innovation System, as illustrated in Figure 5.

The Excellence Framework introduced in this study shares characteristics with the impact model used by Tekes. The Excellence Framework can be observed from below or above. Observing the framework from below describes the principles of **additionality**: the basis for successful economic activities is process excellence, which can then be further enhanced based on offering excellence. For the company to survive in the long term it also needs innovation excellence and, in the very long term, only companies contributing to sustainability and societal excellence will survive. This framework thus corresponds very well to the Tekes Impact Model, which also has four layers (Input-Activities-Output-Impact). However, the Excellence Framework can also be read from above, whereby **excellence** starts from the societal viewpoints, which are addressed through innovations, leading to offerings, which ultimately must be created and delivered through efficient processes. The discussion by Sotarauta et al. (2016) about competence sets includes similar observations. For Tekes, the Impact Model doesn't easily allow approaching the issue of impact from the "above perspective" and may, in itself, be a cognitive blocking factor for Tekes when evaluating its own potential in the Finnish innovation system. The different perspectives are illustrated in the following figure (Figure 8).

When developing the tools to support and measure the activities carried out by Tekes, there is a need to complement the current good practices to provide control of the efficiency of Tekes funding with procedures to also consider the effectiveness, i.e. is Tekes doing the right things to strengthen the attractiveness of Finnish innovation environments? For this purpose, the outside-in Excellence Framework provides a complementary view to the inside-out Impact Framework. Tekes can easily conduct impact analyses by asking its customers about the results of individual projects and programs, unfortunately, however, the feedback can be expected to be biased. Therefore, the ob-

Figure 8. Additionality versus excellence.



servation Veugelers et al (2009, p. 54) made that the central policy-makers do not know the details of the performance of the Finnish national system of innovation, i.e. about the innovation intensities of various categories of innovations (propensities to innovate), is still valid. Subsequent evaluations have also not presented any attempt to develop integrated data regarding innovation intensities for different categories of innovation in the Finnish national system of innovation. Therefore, the observation made by Veugelers et al. on the need for a more solid empirical evidence base to underpin policy formulation is as relevant today as it was 2009.

S5. Control tools. ***Tekes has developed a well-performing set of follow-up measures to evaluate the impact of its innovation support activities, and these should be maintained to secure operational efficiency.***

P9. Steering tools. ***The Finnish national innovation system has inadequate tools to evaluate how to steer the activities towards more effective policies, particularly relating to demand-based ones. Tekes should here facilitate a broad engagement across various actors in both the public and private sectors to address this issue.***

What are the experienced impacts of closer collaboration between organizations (especially Tekes, Finpro, and Finnvera) over the next five years?

Meta-analysis

Tekes has a distinct role in fostering the emergence of new business ecosystem, but long-term impact requires improved synergies between Team Finland agencies. A key lesson from the study is that achieving global competitiveness requires the development of tailored and diverse forms of support, that often stretch beyond the remit and resources of Tekes alone, for business ecosystems (Reid et al., 2016, p. 5).

While the Tekes strategy places an emphasis on supporting innovation ecosystems, the past programs have essentially ceased to serve as funding streams. Now there is a need to focus on systemic impact, which implies a systemic model where collaboration between Tekes and other Team Finland ministries and agencies, as well as other stakehold-

ers, is enhanced to ensure that Tekes funding or services are matched by required actions on regulatory or other enabling conditions, etc. The promotion of various ecosystems requires a different mix of instruments and flexible partnerships. Tekes should pay attention to strengthening cooperation between large/incumbent firms and firms with new business models that act as disruptors or enablers, e.g. digitalization of bioeconomy, in reconfiguring value chains (Reid et al., 2016, p. 28).

One important finding is that development projects, especially in non-technological programs, and their success are mainly dependent on the key personnel involved with the project. Additionally, business model and operational model innovation projects should always include a field test within the actual services in order get sustainable results (Oosi et al., 2016, p. 5).

The programs should have a clearer and more decisive program strategy, especially regarding those goals that are not directly linked to the project funding but to other activities of the program. All three evaluated programs, Muoto, Liito, and Serve, included some kind of objectives which influenced national policy making or innovation funding implemented by Tekes. The objectives have been rather far-reaching and ambitious. Many observations in the evaluation interviews point out that the investment in communication activities was still, despite all the effort, limited towards these goals and, furthermore, that the connections from different types of international networking should have a clear relation to the program objectives (Oosi et al., 2016, p. 11).

The programs had very wide target groups and tried to cover the entire business sector in Finland. When trying to reach research units as well as companies with a wide scope, there is a risk of the programs becoming fragmented. This challenge concerned especially Liito and Serve. According to the findings of the evaluation, Liito, in particular, struggled to get its message through to the business sector, which was seen to be because the program had such a wide context, with essentially any business case falling within the target groups of the program. The message and context of the program was not clear enough for the it to be attractive to companies (Oosi et al., 2016, p. 11).

As companies, have increasingly come to perceive innovation development as a corporate-driven process conducted within ecosystems operating according to global rules rather than within national clusters, the Centre of Expertise Programme has naturally come to the end of its lifespan as a national institution. Therefore, in the future, innovation policy must provide regional expertise with direct access to international hubs where regional operators can supplement their own expertise with that of other locales abroad. These types of networks are often managed by a large corporation while also supporting the integration of research organizations as well as SMEs, also in addition to reinforcing capability building in the network with their own expertise. This report highlights seven core elements to emphasize in response to changes in the operating environment, the need to establish concrete demonstrations and pilots, and the need for closer collaboration between those funding innovation activities and those executing them (Wallin, Laxell, 2013, p. 112).

The authors recommend that growth program activities should be continued after the current funding period, taking into account the improvements proposed in the report. Potential key improvements include a revised funding and oversight model and enhanced cooperation with other programs and service providers (Salminen et al., 2016, p. 4).

Observations from the field

The interviewees in this impact study provided the following viewpoints;

- A key challenge for the Finnish economy is instilling a stronger belief in the future into the country; this requires a broader, shared vision which will guide our efforts to make progress and succeed in global competition.
- The Team Finland actors need to be aligned, they also suffer from the same problem—it is difficult to align independent institutions and funding without an overarching vision.
- The role of Tekes is to understand which competence areas provide the biggest probability of generating new jobs and growth and to selectively allocate funding to such programs and projects that stand the chance of truly improving the competitiveness of Finland. Finpro, in turn, has the role of promoting exports and attracting investments to Finland. Furthermore, the challenge here is having the foresight and insight to allocate attention to such sectors, actors and markets where Finland has the possibility to make a difference. Presently, efforts now seem to be too devoted to various forms of organizational arrangements between different actors within the public innovation system.
- One question that needs to be asked whether we would benefit from having a similar leading institution in Finland, as in e.g. Singapore (industry board), with a core role to drive innovation, university collaboration, and investments. Now the roles are fragmented; Tekes has funding, Finpro brings in investment, Finnvera/Finnfund provides funding, VTT technology, etc.
- Team Finland has evolved gradually, but it is still unclear what the ultimate role of Team Finland should be. Now it appears that Tekes is aiming to become an ecosystem orchestrator. The question is whether Tekes can genuinely, due to its regulated position, have such a position, as ecosystems ultimately should have financial and business objectives and activities.

- Tekes was important in the first phase for us, they provided support, were enthusiastic over the opportunities, and pushed forward. Funding is an excellent product and our export growth story fits their objectives well. They should help companies go to the market more and support development of qualities (quality, leadership, mentoring) which enable the growth of companies.
- We are asked every other week to participate in delegations led by ministers. The high-level introductions, which are the most concrete things these trips offer, are not, however, as valuable to us as they are to e.g. Kone. The picture is that the work of Team Finland is rather generic and they struggle to support SMEs with an approach like ours. Instead of arranging a trip to a waste-to-energy site and having coffee over a PowerPoint presentation, we would value vertical experts in waste management or smart cities (with commercial experience). We believe Team Finland already have such resources themselves or in their network. These experts could e.g. prepare a detailed overview of the German market in waste management to guide the selection of activities with the companies.
- We must now ensure that knowledge and education remain the core pillars upon which the Finnish society rests.
- Team Finland seems to presently be more discussion than action oriented; this could still be valuable, as the competence needed to concretize the initiative needs to first emerge.
- The new Tekes funding strategy makes this impossible for many health companies, especially those that are not politically skilled in gaining funding. This is especially true for those parts of the health industry where many of the key functions relating to innovation are in-house (e.g. pharma) in comparison to those who rely more on their ecosystem (e.g. digital health).
- The original idea for Team Finland was good, i.e. enabling the SMEs across Finland to gain easy access to international expertise regarding export matters. The development has been rather good in setting up Team Finland teams in various important export markets. But the implementation has met severe challenges on the domestic side and SMEs don't understand how they can use this service. Here, the Ministry of Employment and the Economy has an urgent need to properly organize the domestic network, to make it easy for SMEs to gain access to Team Finland services.
- It is also important for Finland to choose its preferred international partners. We should understand that there cannot be very many partners with whom we strategically align our innovation policies.
- How can we become better at integrating ourselves in different international networks?

Conclusions

Tekes, the Finnish Funding Agency for Innovation, is the most important, publicly -funded expert organization for financing research, development, and innovation in Finland. Tekes aims at boosting wide-ranging innovation activities in research communities, industry and service sectors, and promotes a broad-based view on innovation. Besides funding technological breakthroughs, Tekes emphasizes the significance of service-related, design, business, and social innovations (Tekes website).

Based on the results of the interviews in the impact study, the following conclusions regarding Tekes's role in the Finnish innovation environment can be drawn:

- The main role of Tekes is to provide resources (networks, knowledge, and financial support) to the actors in the innovation system. Open data, biobanks, and funding for companies in the growth stage are examples of important resources for the future. Tekes's ability to prioritize the limited resources remains a challenge, both in respect of financial resources as well as knowledge resources that can be mobilized by Tekes.
- Market co-creation has, thus far, only been in limited use by Tekes and Team Finland; one example of a successful contribution has been the support of LNG technology for the shipbuilding industry, which has proven to be a valuable asset for Meyer Turku and its ecosystem today. This, however, is an area where the government could, broadly speaking, serve a more important role in the future, e.g. related to the SOTE and transport reforms. This would have to engage not only Tekes and Team Finland, but also other public actors such as other ministries, social and health care districts, and city governments. The toolbox in this area should also include legislation, regulation, incentives, and tax policies.
- The role of the public sector as orchestrator seems to be possible in two specific circumstances. Firstly, in the very early stage of the formation of a new technological or institutional field, such as energy storage or autonomous vehicles, wherein the focus is on capability building and no clear candidate for the commercialization exists. Secondly, when the public sector itself is a significant customer, as e.g. in social and health care and transport services. Otherwise, the orchestrator role should be handled by somebody with the authority to also make commercial commitments on behalf of the ecosystem. However, when providing support to such orchestrated ecosystems, it is crucial that the public sector ensure that the value from these supported activities is appropriated and that the sought-for capability building efforts are also accomplished.

Tekes's role in the future of the national innovation system must be anchored in a collaborative setting with the relevant Finnish innovation actors committed to the principles of a Lean National Innovation System outlined in this report. We believe that the present challenges facing the Finnish economy are of such a magnitude, that only an open and creative dialogue among the key stakeholders in the innovation system can solve the present problems.

The different elements that we suggest to form the basis for the updated innovation policy all exist. Four major principles however differ from the present emphasis:

1. We believe there is a need for a more specific definition of the central innovation themes to form the basis for mission-driven innovation in Finland. The notions of bio, cleantech, digital, and health are here too vague. The Strategic Innovation Initiatives fill the present gap.
2. There should be a more explicit discussion about the type of innovation support activities to be carried out, their objectives, and how resources will be allocated across the various activities. Here, emphasize, in particular, the potential of broader public engagement around key societal issues such as social and health care, transport, and waste management.
3. Successful innovations increasingly call for engagement in international networks and attracting of international actors to actively contribute to the Finnish innovation landscape. This requires a much more sophisticated way of integrating the activities of start-ups and SMEs with those of large companies, which calls for stronger involvement from Tekes, Team Finland, Academy of Finland, and relevant ministries, to identify and exploit possible synergies. Here, Tekes should be the primary facilitator of an open exchange of ideas and viewpoints.
4. The government must adopt a portfolio approach, wherein the objective to constantly strengthen governmental capability requires strong coordination across the various initiatives and activities carried out in the national innovation system.

The capability map (Figure 2) can be used as an operational tool to focus the capability development in an effective way. This also provides a better way for understanding how the roles and responsibilities of Team Finland can be defined and communicated better to address the recent criticism that Team Finland has received.

We believe that the original idea behind Team Finland, providing a one-stop shopping experience to the customer, was theoretically appealing, but flawed in practice. During the period 2008-2011 there were several Finnish multinational companies that entered a One Company program, which were quietly abandoned two to three years down the road. These One Company programs failed because they created additional bureaucracy and internal turf fighting, which ultimately shifted the focus away from the customer interaction and towards internal politics. The recent media reporting about Team Finland reveals similar characteristics.

In today's increasingly digitalized world we don't see a need for the Finnish government to internally "package" the competencies of its various Team Finland service organizations to serve startups and SMEs. When entrepreneurs have a genuine need for a specific service from a Team Finland organization, they can use the existing communication channels to contact the expert in the relevant organization. It is more important that each Team Finland organization ensures that its services are continuously updated and professionally delivered. With the aid of the capability map, we would argue that the focus of each Team Finland organization must be on securing that the Process Excellence is state of the art in their own field.

Tekes has a strong brand as the leading expert in Finland in respect of R&D and innovation support while Finnvera has a clear role in export financing and state guarantees. Both organizations have also received positive feedback in the interviews conducted in this impact study. These clear roles in the innovation system have enabled them to maintain their basic functions without major disturbances from the Team Finland reorganization.

For the remaining Team Finland organizations, the situation is more problematic. Finpro has been going through a transition period in dismantling its paid-for consulting services after failing to properly establish a viable market as broker of such services. VTT is constantly under pressure due to cost cutting among its major customer segment, large Finnish industrial companies. Industry Investment is an investment company that accelerates companies' success stories by investing in them, both directly and via funds. However, it is unclear how this investment function fundamentally differs from private investors, raising the question of what role it has in strengthening the Finnish innovation environment.

In the context of the analyses provided in this report, we suggest that integrating the activities of all Team Finland actors into the process of establishing the Strategic Innovation Initiatives would be one way to provide stronger synergies across the various organizations constituting Team Finland.

A new element in the Finnish national innovation system is the SOTE reform. If this reform is implemented according to the present plan, the role of the ELY Centers will be transferred to the counties in 2019, as the counties are intended to take over some of the tasks of the Centres for Economic Development, Transport, and the Environment; Employment and Economic Development Offices; Regional State Administrative Agencies; regional councils; and municipalities.

When considering how the provision of innovation support activities should be carried out locally, we argue that there are regional differences. The operational structure for coordinating local activities with national support activities is more complicated than the present approach which only discusses such regional/national integration in the context of Team Finland. For a fast-growing company, export support, recruitment of refugees as employees, possibility for investment subsidies, and applicability of environmental legislation may all be relevant issues for the present dialogue with the ELY Centre. As this example shows, the responsibilities of the ELY Centre towards the individual customer are much broader than the Team Finland agenda. Subsequently, trying to implement a separate national/regional scheme for only Team Finland issues only creates confusion and increasing bureaucracy.

S6. Customer service. ***Tekes's customers consider its services to be good, and this provides a strong foundation for Tekes to take an even stronger role in supporting its customers in the future.***

S7. Tekes brand. ***Tekes has a well-recognized brand, both domestically and internationally. Using the brand to strengthen the internationalization of the Finnish national innovation system should be a top priority.***

Summarizing the evaluation

The two main conclusions from the evaluation here conducted are as follows:

- **There is a need to go beyond the current flurry of program creation and take the lead in exploring what the next generation national system of innovation should be.**
- **The root cause of the present difficulties is the underdeveloped governmental capability.**

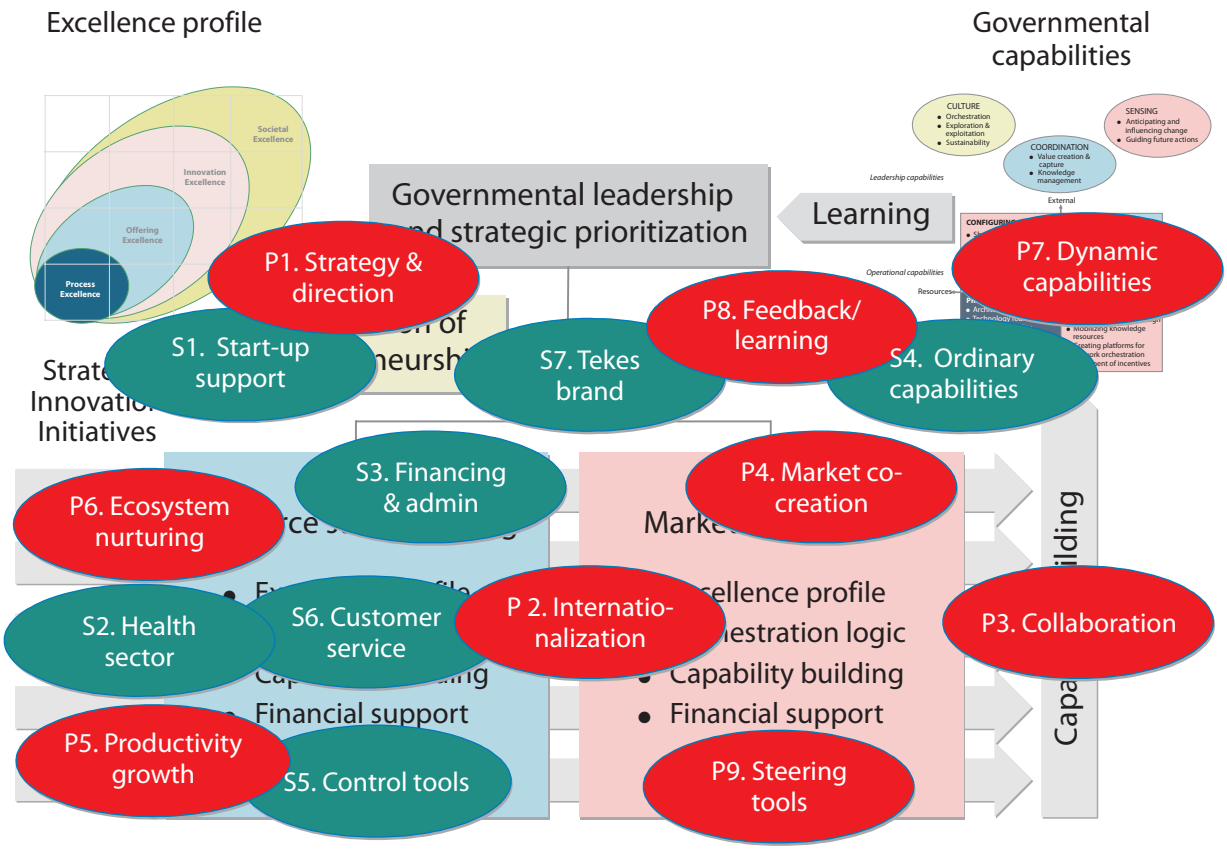
The evaluation has shown that the suggested Lean National Innovation System framework is well suited to the present needs of Finland when trying to improve the attractiveness of its innovation environments. We also find that the six propositions suggested as the foundation of this evaluation were valid and that the meta-analysis and the evidence from the field could provide insightful and relevant observations relating to each of the propositions. In addition, the propositions also enabled us to make a more fine-grained evaluation of how Tekes has succeeded in its ambition to strengthen the attractiveness of Finland as an innovation environment.

We use the Lean National Innovation System framework as the background to provide an overview of how Tekes supports the attractiveness of the Finnish innovation environment as illustrated in Figure 9. The strengths (S) of Tekes are indicated with green ovals whereas the potentials (P) to further leverage the role of Tekes in the national Finnish innovation system are indicated with red ovals in the figure.

As we can see from Figure 9 the strengths of Tekes are on the left side of the figure, i.e. relating to the resource provision, while the major potential appears on the right side, i.e. on the demand-side. We also see the inside-out perspective being a strength when providing customer service, establishing proper administrative and control processes and cultivating the ordinary capabilities. The main potentials lie in Tekes taking an even more forceful role in showing the direction for Finland in the present, difficult situation. The focus on programs and funding has not been sufficiently strong in promoting collaboration with other stakeholders or the formation of strong new ecosystems. Here, a positive exception is the recent effort in the health sector.

Nonetheless, Tekes has a strong brand and an excellent relationship with the Finnish business community. The most visible new success story is the games sector, but, considered more broadly, Tekes has, very determinedly, reallocated resources to the start-up sector as of late. However, as indicated in this report, funding is not enough. Establishing the proper ecosystems and considering the productivity requirements are essential ingredients in a successful and attractive innovation environment. This requires a more systemic effort within the Finnish innovation system than present efforts. A key requirement for this will be adequate governmental capability. In the following section, we make our recommendations for how such a national innovation system could be established.

Figure 9. Summary of evaluation.



Part III
Recommendations

The ambition of the Finnish research and innovation policy is to create sustainable growth and wellbeing. In seeking means to accomplish this objective, the Finnish government has identified several challenges (Research and Innovation Council, 2014):

- The structural change of the Finnish industries and business sector
- The prolonged recession
- Reduced economic resources
- The long-standing strengths are not enough to tackle the crisis
- Limited confidence in Finland as an innovation-driven economy.

This suggests that Finland's strengths must be translated into practical advantages, commercial success stories, and new jobs. This impact study has been done to produce a forward-looking evaluation analysis of how Tekes and Team Finland, as well as their collaborators, will succeed in their objectives related to the goal of making Finland an attractive innovation environment. The impact study has taken into consideration those factors of innovation environments in the Finnish economy and society essential to Finland becoming one of the world's most attractive countries in respect of innovation.

The research has proceeded in three steps. First, we conducted an in-depth literature review and carried out interviews to operationalize the notion of an attractive innovation environment. This forms the first part of this report. The result of this was the emergence of a new framework, the Lean National Innovation System. Second, we used the established framework to formulate seven questions to be addressed to assess the present state of the Finnish innovation environment, and evaluate how well Tekes has been able to support the attractiveness of this environment. The evaluation confirmed the relevance of the Lean National Innovation System as a tool to assess the attractiveness of a national innovation environment, and the possibility to also evaluate an individual innovation agency in the context of the national innovation environment. Our evaluation identified seven present strengths of Tekes, along with another nine areas where Tekes could further leverage the attractiveness of the Finnish national innovation environment. Third, based upon the conceptual framework and the assessment of the Finnish innovation environment, this final part of the report provides some concrete recommendations for further improving the attractiveness of Finland as an innovation environment.

The recommendations here presented can be summarized into three key core activities to be carried out in parallel. These activities will also call for new priorities from the key actors in the Finnish innovation system:

- Solidifying the governance of the Finnish innovation system, putting the Research and Innovation Council firmly in charge of the stewardship of the transformation of the national innovation system ("stewardship").
- Ensuring proper process support for the transformation of the national innovation system by establishing an Innovation Transformer function hosted in Tekes as the administrative body of the Finnish Lean National Innovation System. The Innovation Transformer function is responsible for the continuous strengthening of governmental capabilities and monitoring and supporting Strategic Innovation Initiatives ("governmental capability building").
- Increasing the efforts to get Finnish businesses and research institutions inserted in strategic global networks by assuring that Team Finland actors, leading universities, and relevant ministries are aligned with the global objectives of the Finnish innovation and industrial policies. Building such global pipelines calls for collaborative efforts between governmental agencies, researchers, and companies to create the critical mass of knowledge needed to become attractive for relevant global partners ("institutionalizing global pipelines").

What suggestions and recommendations are made for improving the Finnish innovation environment in general?

We use the notion of stewardship to indicate a form of responsible leadership, which is based on a continuous quest for improvement on all four levels of the excellence framework: process excellence throughout the society, offering excellence for companies and public services, innovation excellence in various forms of networks and ecosystems, and, ultimately, societal excellence, i.e. guiding the development in Finland with a strong national intent to be a forerunner in shaping the next generation of societal structures.

In our assessment, we presented two propositions related to the stewardship perspective, and for each proposition we also identified implications for Tekes:

Proposition 1. Finland is an example of the European paradox; this requires a rethinking of the national innovation system.

S1. Start-up support. ***Tekes has actively supported the strengthening of the start-up culture in Finland.***

P1. Strategy & direction. ***Tekes should, in the future, take a more active role in the public debate.***

P2. Internationalization. ***Tekes needs to, even more actively, support the internationalization of Finnish SMEs.***

Proposition 2. The rapidly changing context of national innovation environments requires stronger steering from the national government.

S2. Health sector. ***Tekes has actively driven innovation collaboration in the health sector, collaborating with large international companies such as GE Healthcare and IBM.***

P3. Collaboration. ***Tekes could more actively drive collaboration across various public sector actors in the Finnish innovation system outside the realm of Team Finland interacting with several sectors such as economic, labor, transport, environmental and regional policy, the Academy of Finland, as well as social welfare and health care.***

P4. Market co-creation. ***Tekes should strengthen demand-based innovation policies alongside its supply-based innovation policies.***

P5. Productivity. ***Tekes should more actively seek prioritized areas that will also offer enhanced productivity and value capturing opportunities for the Finnish economy.***

The need for stronger stewardship requires a broad acceptance and legitimacy for the chosen innovation direction among different stakeholders, citizens included. This leadership cannot only be processual in its nature. It must also be anchored in a prioritization of the key substance areas in making Finland one of the world's leading innovation environments. This emphasizes the need for direction, collaboration, and market co-creation. In the second part of this report we presented four substance areas that could form the foundation for a new, more dynamic innovation culture. We will briefly review the arguments for why we think the four selected themes are strong candidates to become pillars of the next-generation Finnish innovation system and, in this respect, enhance the attractiveness of the Finnish innovation environment.

Social and healthcare systems represent what has been estimated to become world's single biggest area for innovation by 2018. As Finland now undertakes a fundamental reform of the national social and health care system (the SOTE reform), there is a strong need to integrate innovation into the development work at hand.

Urban transport has been a focus area for development in the biggest Finnish cities for more than five years. Thus, there are many companies that have developed new solutions that have generated growth and export revenues. The capital region and the cities of Turku and Tampere are committed to introducing new concepts for mobility as a service and electric vehicles, providing fertile demonstration ground for further development. Nokia spin-off Here is also actively working with Finnish enterprises to drive this development further.

Adaptive manufacturing ecosystems provide a new perspective on establishing cooperation in old industries. The job creation of the two companies used as illustration, Meyer Turku and Valmet Automotive, represents one of the most dynamic industrial growth sectors in Finland today. The presented proposal has also been validated by the two companies, who agree with the conclusions and support the suggested approach.

Waste management and recycling is an area of strong global growth. But it also represents an area where there is a need for long-term investments and systemic, public-private orchestration. This is the situation in many so-called cleantech sectors. Such orchestration calls for a critical mass. Very few Finnish companies can aim for global expansion in this area. However, the merger of Ekokem and Fortum has created a candidate for such development and Fortum has confirmed its interest in evaluating this opportunity.

As the examples indicate, our ambition has been to carry out the first "acid test" of our proposed approach and use this as a basis for our recommendations to the Finnish government, Tekes, and Team Finland (more detailed suggestions about the Strategic Innovation Initiatives can be found in Appendix 6).

The Lean National Innovation System (Figure 5) requires visible stewardship from the top. This stewardship should be based on a continuous dialogue with various stakeholders and an open attitude to new insights arising from the continuous changes in the contextual environment. It also renews itself based on the learning going on in the various activities guided by the governmental stewardship.

Traditionally the Finnish innovation policy has had strong guidance from the top. The original ambition of the SHOK program was also largely based upon these principles. However, the governance model of the SHOK program was flawed as the government abdicated its stewardship role. Thus, we argue a strong stewardship should be the first requirement for Finland to regain its position as a role model in respect of innovation systems. The need for support in a broad sense is illustrated by the following customer quotes:

The main attraction factor of Finland is the availability of competence. We mainly recruit individuals who have at

least eight years of experience if our field of expertise. The collaboration between corporations, VTT and universities is also important. This is supported by the way the Finnish government and the Ministry for Foreign Affairs help Finnish subsidiaries of foreign companies to build the relationships with the corporate headquarters.

One thing which the government could do better is to provide foreign companies in Finland with detailed instructions of the administrative routines they must fulfill, relating e.g. to work permits, health insurance, taxes, occupational health etc. This to avoid excess bureaucracy and investigations at a later stage. For a local manager in Finland it is difficult to argue in these matters with the corporate headquarters. Having an official document to share with the corporate lawyers and administrators would make these types of discussions much more effective.

When we talk about stewardship we talk about leadership and engagement. Recently, Finland has been preoccupied with management and organizations. Therefore, we recommend using, as far as possible, pre-existing organizational frameworks and providing existing organizations with new mandates, more clearly defined roles, and well-communicated responsibilities. Crucially, this process should start from the top. Thus, we suggest that ownership of the stewardship role in the Finnish innovation system should be taken by the Prime Minister and the Research and Innovation Council. Our stewardship recommendations are as follows:

1. **The Finnish government and the Research and Innovation Council (TIN, Tiede ja innovaationeuvosto) will intensify their efforts to steer the innovation and industrial policies in Finland by prioritizing the innovation objectives through the allocation of resources for stimulation of entrepreneurship, resource strengthening, and market co-creation. TIN will supervise the governance of the government support for innovation activities through:**
    a. **The Innovation Transformer supporting TIN will secure alignment across the activities to drive stimulation of entrepreneurship, generic resource strengthening, market co-creation, and Strategic Innovation Initiatives (SIIs). A key objective of the Innovation Transformer function is to strengthen governmental capability building on a national level. Tekes should host the Innovation Transformer function.**
    b. **SII Executive Committees coordinating the SIIs. The chairmanship of each initiative should, where possible, reside within the ministry with the primary responsibility for the legislative and funding issues relating to the initiative. The secretary of the Executive Committee should be a member of the Innovation Transformer function. The Executive Committee shall meet at least quarterly.**
    c. **SII Orchestrators engage the participants in the SIIs for capability building and support the insertion of Finnish participants in international networks. Depending on the type of operational duties relating to the initiative, the orchestrator will supervise one or several taskforces through which the activities are carried out. An Orchestrator should be a highly-respected individual in his or her field and be invited by the government to carry out the orchestrating task.**

The comparisons between the Finnish innovation environment and those of Sweden, Norway, the Netherlands, Belgium, and Japan have shown that there is a trend among national authorities for stronger guidance from the top in strengthening their innovation systems. Finland has been a pioneer in pursuing a broad innovation policy and involving the government in a responsible way to strengthen the national innovation agenda. We believe that this tradition should be continued. This recommendation is supported by recent trends in the corporate world, where corporate CEOs take personal responsibility for directing and inspiring innovation as it becomes an ever more vital element of business survival and success (PwC, 2016). We foresee that a significantly bigger portion of resources allocated for innovation activities is devoted to market co-creation activities; with social and health care reform and transportation reform being prime examples of areas where this is already going on. Selecting the Strategic Innovation Initiatives should primarily be driven by the ambitions to speed up market and ecosystem co-creation, but also ensure value capture, productivity improvements, and capability building. How GE Healthcare balanced these views is illustrated by the following quote:

When GE Healthcare made the decision to launch the Mobile Digital Health Program, it was not at all clear that the corporate mandate would be given to Finland. One could say that the competition was between the Finnish concept and a combined effort by GE US and GE India. The decision to choose Finland as the main location of the program was based on three major factors. Firstly, the cost-competitiveness of high-quality western engineering skills. Secondly, the strong wireless and digital competences in Finland. For GE Healthcare wearable health technologies are one key area when developing future products and services. Thirdly, the positive experiences from long-term collaboration with the customers, the leading hospitals in Finland, primarily HUS, the Hospital District of Helsinki and Uusimaa, a joint authority formed by 24 municipalities, with Helsinki University Hospital as its medical competence center, but also with other leading Finnish hospitals.

The role of Tekes as the host of the Innovation Transformer function will be particularly important in integrating the capability building across the various Strategic Innova-

tion Initiatives. It is also important to gather annual feedback from the on-going activities to evaluate the progress of each Strategic Innovation Initiative. To ensure proper external evaluation there will be a process of continuous monitoring of the changing business context of the respective initiatives, the orchestration of activities relating to the initiative, the capability building efforts within the initiative, as well as the results of the financial support provided to the initiative. The ongoing activities mobilized by Tekes in the health sector are an example of this form of new approach to the formation of innovation ecosystems.

What suggestions and recommendations are made for how Tekes can improve its impact on the Finnish innovation environment?

Finland is lacking a public discourse on the need for new types of capabilities in the national innovation. This is a main shortcoming of our national innovation system. This report has identified several measures to improve the attractiveness of the Finnish innovation environment, and, based on our original propositions, we grouped them into four different categories in our evaluation in the second part of this report:

Proposition 3. To enable the proper alignment of resources under control of the national government, there is a need to clearly define the priorities of the national innovation policy, which requires the support from a dedicated actor providing the government with views on how to steer the innovation policy.

S3. Financing and administration. *Tekes has been able to efficiently adapt to new requirements regarding its processes and offerings, including new funding rules and mechanisms, when the external conditions have changed.*

P6. Ecosystem nurturing. *As ecosystems are increasingly the source of innovation and competitiveness, Tekes should further increase its efforts to support the formation of international ecosystems in selected competence areas where Finland has some distinctive comparative advantage.*

In addition, *we can note that internationalization (P2) and collaboration (P3) are emphasized in this section.*

Proposition 4. The implementation of the innovation policy will simultaneously, through resource allocation in dedicated government-supported strategic innovation initiatives, co-create value in ecosystems and (new) markets, capture a relevant portion of this value in protectable national institutions, and contribute to knowledge creation and capability building.

When considering the role of Tekes in the prioritization of innovation policies in Finland, it is further confirmed that Tekes has an important role in influencing decision making on collaboration within the public sector (P3), internationalization (P2), market co-creation (P4), and ecosystem nurturing (P6), particularly to insert Finnish companies into global networks.

Proposition 5. The nurturing of the national innovation system will be handled by actors building governmental capability and supporting the government with continuous information about (i) the status of the system, (ii) the evolving operational context of the system, (iii) and to what extent there is a need to adjust the system to adapt to identified changes, internal to the system and in the external environment.

S4. Ordinary capabilities. *Tekes has the capacity to be the innovation agency for the Finnish government, therefore, major changes to Tekes's operational governance are not necessary.*

P7. Dynamic capabilities. *The present turbulence in the world economy calls for strong dynamic capabilities from Finland and its innovation system actors. Tekes should here take the lead and facilitate the formation of knowledge alliances with trusted international experts to strengthen the dynamic capabilities of the Finnish innovation system.*

P8. Feedback/learning. *The meta-analysis of this report has shown that many of those issues that are now addressed by the Team Finland working group have been identified in previous impact studies and reports. Tekes should make sure that there are processes in place that will continuously evaluate how feedback and lessons learned are implemented.*

Proposition 6. The steering of the new national innovation system requires new tools and incentives, which should gradually be taken into use to secure an efficient transition from the old to the new.

S5. Control tools. *Tekes has developed a well-performing set of follow-up measures to evaluate the impact of its innovation support activities, and these should be maintained to secure operational efficiency.*

P9. Steering tools. *The Finnish national innovation system has inadequate tools to evaluate how to steer the activities towards more effective policies, particularly relating to demand-based ones. Tekes should here facilitate a broad engagement across various actors in both the public and private sectors to address this issue.*

S6. Customer service. *Tekes's customers consider its services to be good, and this provides a strong foundation for Tekes to take an even stronger role in supporting its customers in the future.*

S7. Tekes brand. *Tekes has a well-recognized brand, both domestically and internationally. Using the brand to strengthen the internationalization of the Finnish national innovation system should be a top priority.*

This report strongly advocates a view that innovation and industrial policies are more important than ever. However, what is needed is a fundamental upgrade of the capabilities within the national innovation system. This will be the main responsibility of Tekes hosting the Innovation Transformer function. In the following we present some concrete suggestions for how this capability upgrade can be initiated.

1. **Tekes, as the host of the Innovation Transformer function, will take responsibility for the governmental capability building within the Finnish public sector in an action-learning mode, beginning with the initiation of the new practice in a limited number of pilot Strategic Innovation Initiatives.**

The capability map (Figure 1) can be used as an operational tool to focus the capability development in an effective way. This also provides a better way for understanding how the roles and responsibilities of Team Finland can be defined and better communicated to make Team Finland more effective. Today Tekes meets a very broad array of demands from the customers:

As the Finnish R&D unit is relatively small, it has primarily to sell its services to the business units within the corporation. This means that the success is dependent on how well the targeted business unit will get funding for its own projects. If one chooses a unit/project that will not get funding, then one must start again with some other initiative. To improve the probability of getting funding we can leverage upon larger competence bases than purely our own employees, and in certain cases funding from e.g. Tekes will strengthen the proposal. If a project gets approval it will have immediate employment implications in Finland. This logic has been explained to Tekes, but it has been very difficult to find financial support from Tekes in these types of situations. This is an area where Tekes should look for ways to be more flexible.

In the context of the analyses provided in this report we suggest that integrating the activities of all Team Finland actors into the process of establishing the Strategic Innovation Initiatives will provide synergies across the various organizations constituting Team Finland. The requirements of the Strategic Innovation Initiatives should be the main integrating element across the Team Finland actors. Each Team Finland organization will focus upon developing its own processes and services to be able to service customers with the highest professional standards, short lead times, and demands for cost efficiency. Customers expect to deal with the real experts, and, consequently, the services provided by each individual Team Finland organization must be clearly profiled.

The Innovation Transformer provides the highest-level orchestration support for the national innovation system, the objectives and performance indicators of which are established by TIN. This new role for Tekes will call for constant adjustments of the operational measures in respect of resource provision, capability building on initiative level, and market and ecosystem co-creation. The dynamic capabilities needed to handle this task are built by establishing a semi-permanent knowledge alliance: The Innovation Reference Group, with leading experts from both Finland and abroad to support the Innovation Transformer function with constructively critical on-going assessments of how the transformation of the Finnish innovation system is progressing.

2. **To secure accountability, integrity, and transparency of the transformation of the innovation system a separate Innovation Reference Group will be established with the objective to critically monitor and reflect upon the progress of the reform of the Finnish innovation system.**

To avoid the risk of establishing an important element in the innovation system architecture fails it is suggested that the Innovation Reference Group has a five-year mandate. Nonetheless, it should annually provide a thorough self-evaluation of both the group achievements and individual contributions to TIN. This would rapidly reveal whether this group can perform its duties or not. If the performance is not satisfactory, TIN would have the right to annually reorganize the Innovation Reference Group based on the self-evaluations.

Recommendations on how actors of Team Finland (especially Tekes, Finpro, and Finnvera) can improve their impact on the Finnish innovation environment?

For the innovation environment to be attractive it must be active in international interaction. A key component in pursuing innovation excellence in the Lean National Innovation System is global networking with top universities and researchers. In selecting the Strategic Innovation Initiatives, the starting point should be that it is not very probable that Finnish universities or VTT would possess all the leading global knowledge on a general level in the selected substance areas. However, as the selected fields will be of such nature that they are rapidly reconfigured by public-private collaboration with strong involvement of individual citizens, the role of research is also changing. We are not talking about traditional linear research, but iterative action research. The attraction for international researchers would thus be the clock-speed by which concrete results are achieved. Finland has a competitive advantage in this respect thanks to well-established processes for collaboration between industry, government and the research institutions. This would form the basis of a new perspective on

how to allocate research resources to support the innovation agenda:

1. **Team Finland actors and Finnish universities and VTT should be strategic partners in the formation of the global ecosystems needed to make the Strategic Innovation Initiatives successful.**

The need for multi-party collaboration is illustrated by the following statement from Meyer Turku:

The emphasis of Turku shipyard is on making the production process even more efficient (the Turku shipyard product development and project design processes are already very competitive). An investment program has already been approved to improve the efficiency and shorten the production times for the Turku shipyard and more is in the pipeline. In this work, Meyer Turku is also expecting support from the Finnish innovation system, through financing but also through new innovative approaches provided e.g. by universities and VTT. For the Turku shipyard, it is important that also the underlying resources for continuous research, development, and innovation are secured in the innovation system. Here Tekes has an important role in steering research programs in such a way that the marine sector can maintain its competitiveness internationally. The fact that the customers of Meyer Turku, such as Royal Caribbean International, also use the services of VTT illustrates the attractiveness of the Finnish innovation environment in the marine sector.

The practice of international collaboration within universities and VTT has been heavily based on a bottom-up perspective and the abilities of the individual professors to establish international linkages. Universities in the Anglo-Saxon world are much more focused in their research strategies compared to Finnish universities. There are arguments that elitism should be promoted, as only world class results will, in the long-term, secure the longevity of a research institution (Sipilä, 2016). But it has also been noted that pioneers in new technology do not always manage to stay on top, and, e.g. in the race to transform the future of transport, much will depend on which firm best handles the regulators. By actively integrating universities in the formation of the Strategic Innovation Initiatives, the attractiveness of these initiatives will be considerably higher from an international perspective, especially if the participating global companies would support the universities in their efforts to build the needed global pipelines.

2. **When forming the Strategic Innovation Initiatives, Team Finland actors should be key actors in establishing global pipelines through which both commercial and research collaboration can be strengthened over time. The universities and VTT should also be committed to supporting the schedules and requirements of the commercial partners in the ecosystem based on flexible support from the national innovation system, e.g. through special funding arrangements. In the early stage of capability building, the key expertise may be available only outside of Finland. For such cases, more flexible innovation support instruments should be developed to attract the required expertise to Finland.**

The attractiveness of the innovation environment in a substance area is built up over time. This process calls for the government to flexibly use its toolbox to provide resources, support market and ecosystem co-creation, and build the necessary capabilities. It also calls for deeper collaboration, as illustrated in the following company quote:

Our Helsinki Hub focuses on mobile and UX products. Keeping with our mobile first approach and platform strategy, our first product is a new app for customers, while creating direct connections between brands, retailers and consumers. In addition, we're active in the local startup scene and contribute to the local tech community by hosting meetups every week. Technology is a core competence. This is reflected in the personnel of the Helsinki office. Also the role of the Helsinki office has been expanded from applications, to the development of the technology platform and other R&D tasks.

This impact study has argued that such ecosystems will increasingly call for social innovations. Health care and wellbeing, transport, and waste management are examples of societal challenges where the ultimate result will be dependent on the collaboration between the public and the private sectors. The outcomes also depend increasingly on the ability of politicians to initiate societal and behavioral change. When such processes of change are implemented, they will need evidence-based approaches. This offers Finnish innovation actors significant opportunities to emerge as a leading nation in the orchestration of such complex collaborations in practice. Integrating the universities and research institutions in the verification of the results of these societal innovations, and speeding up the dissemination of the new knowledge, will contribute to the strengthening of Finland as an innovation environment in the prioritized substance areas.

When considering how the provision of innovation support activities should be carried out locally, we argue that there are regional differences. The operational structure for coordinating local activities with national support activities is more complicated than the present approach, which only discusses such regional/national integration in the context of Team Finland. This is illustrated by the following quotes from a customer interviews:

The firm has been able to utilize the strong electronics, RF, and audio competence, HW-oriented software develop-

ment, and local innovation infrastructure, including university, services, and complementary companies available in the city. The firm has been able to develop the equipment from start to end. Also, testing, IT-administration, and manufacturing competences have been available. For a company of our size it is important that we can do everything on one site, to be able to compete with much larger competitors.

The international employees and partners state that the type of innovation environment existing in Finland (incl. Tekes support grants, support services, and the availability of professionals) is rare, this is something that should be marketed (instead of university strengths). The city and partners have been doing a good job in searching for international firms that appreciate the type of strengths we also need.

For a fast-growing company, export support, recruitment of refugees as employees, possibility for investment subsidies, and applicability of environmental legislation may all be relevant issues for the present dialogue with the ELY Centre. As this example shows, the responsibilities of the ELY Centre towards the individual customer are much broader than the Team Finland agenda. Subsequently, trying to implement a separate national/regional scheme for only Team Finland issues is only creating confusion and increasing bureaucracy.

3. **The role of ELY Centres in the Team Finland context should be dealt with in the broader design of the future national and regional integration based on the existing plans for the Health, Social Services, and Regional Government Reform. The capability building needs of the future counties should already be integrated into the capability building roadmap of the Innovation Transformer.**

All four suggested Strategic Innovation Initiatives are such that they would favor an involvement of multiple locations in the establishing of the innovation ecosystem, providing demonstrations and pilots to be used by participating companies to strengthen their export activities. However, these efforts, if properly orchestrated, could also contribute to the national capability building within the respective competence areas.

Proposed next steps

The main objective of this impact study was to "produce a forward-looking evaluation analysis of how Tekes and Team Finland, as well their collaborators, will succeed in its objectives related to the goal of making Finland an attractive innovation environment." It was also seen that achieving the objective would involve taking into consideration those factors of innovation environments that are essential to the Finnish economy and society for Finland to become attractive at the top level internationally. The main finding of our study has been the recognition that increasing its attractiveness as an innovation environment, would call on Finland to profoundly overhaul its innovation system. In this report, we have presented the framework for such a new type of innovation system that we call a Lean National Innovation System. The following figure illustrates how this framework can be applied in the Finnish context (Figure 10).

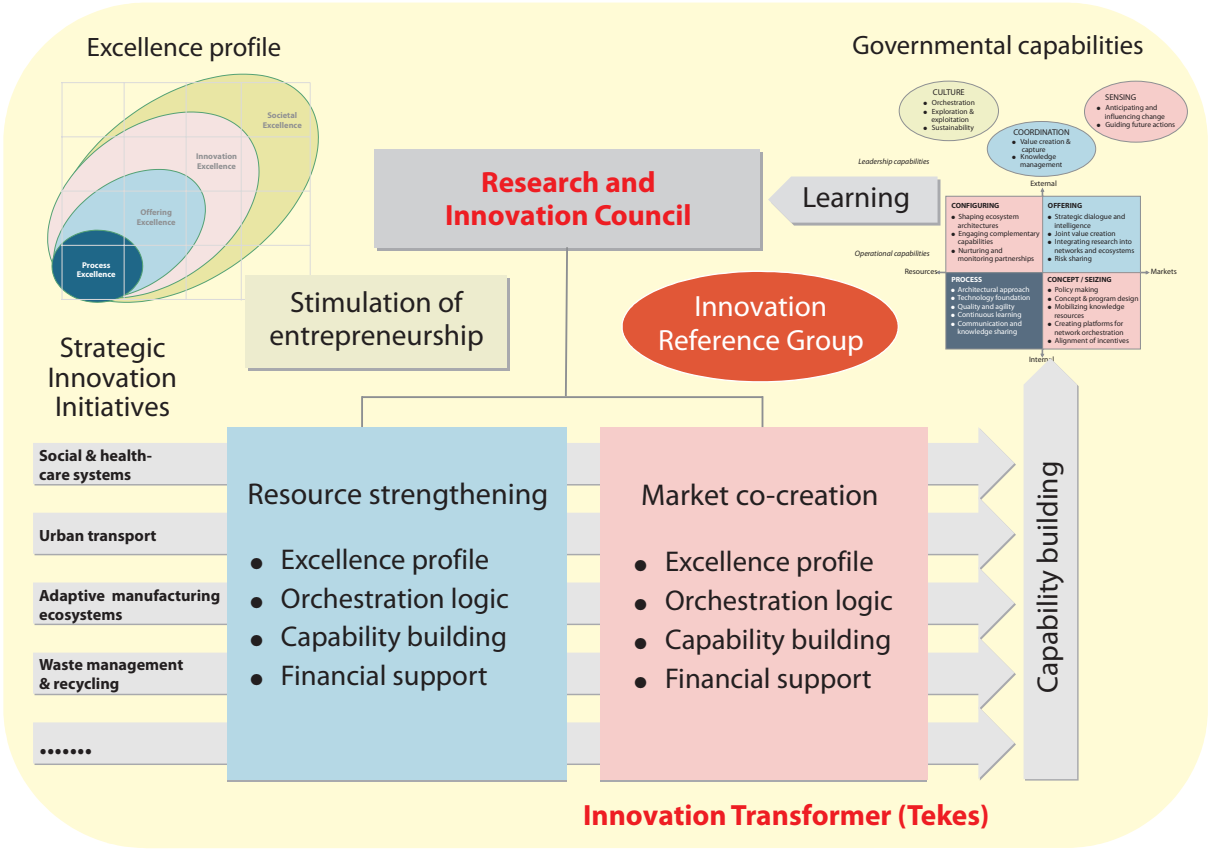
The results of the impact study are presented in this report. The nature of the study has been exploratory. We have challenged the original boundary setting of the impact study by not restricting our analysis purely to the domains of Tekes and Team Finland collaborators. Collectively we, as authors, feel that we have a solid and strongly grounded argument for why and how the Finnish national innovation system should be transformed. However, the suggested recommendations would call for a significant commitment from the top to enable the suggested transition. Therefore, political commitment must be guaranteed before deciding on how to move forward based on our recommendations.

If there is political commitment to move ahead, the following step would be to secure that the marching orders are in synch with other ongoing reform activities supervised by the Finnish government. We envisage that a piloting phase of six months should be enough to operationalize the Lean National Innovation System. We see three key activities to be carried out in parallel during this piloting phase:

1. Operationalizing the governance structure, particularly the organizing of the Innovation Transformer function.
2. Drafting the arrangements and action plans of the selected Strategic Innovation Initiatives.
3. Anchoring the new ideas among key innovation actors including Team Finland organizations, relevant substance-owning ministries, leading universities, key social and health care districts, as well as selected interest groups and NGOs.

Based on an intensive effort from a group of experienced professionals over a period of six months, we feel confident that the here presented guidelines could be operationalized into an actionable policy document, becoming the basis for taking the Finnish innovation system to the next level. Using the suggested candidates for Strategic Innovation Initiatives (Social and healthcare systems, Urban transport, Adaptive manufacturing ecosystems, and Waste management and recycling), as pilot cases for how to move forward, we think rapid progress could be achieved. By working closely with the various actors relevant for forming the innovation ecosystems around these topics, it would be possible to test the process, from the outset, of action learning which should characterize the Lean National Innovation System.

Figure 10. The Finnish Lean National Innovation System.



Appendix 1. Literature review, attractive innovation environments

In the book *The Competitive Advantage of Nations* (1990) Michael E. Porter introduced four determinants of national advantage: (i) factor conditions, (ii) demand conditions, (iii) related and supported industries, and (iv) firm strategy, structure, and rivalry. Porter suggested that even if globalization increases, the home nation, nonetheless, plays a central role in a firm's international success, as it shapes a company's capacity to innovate rapidly in technology and methods and to do so in the proper direction. Nations gain advantages as result of differences, not similarities. Another important observation was that "outsiders" are often the catalysts for innovation. Thus, competitive advantage is sustained only through relentless improvement and most durable competitive advantages usually depend on possessing advanced human resources and internal technical capability. Porter's recommendation was to promote industry or cluster programs for factor creation, i.e. continuous capability-building.

Porter emphasized competitive positioning from a firm point of view (see Porter, Stern, 2001) and was less occupied with collaboration. A parallel stream of development focusing on national innovation systems started simultaneously (Freeman, Lundvall, 1988; Lundvall, 1992; Nelson, 1993, Freeman, 1995, Fagerberg, 2015). This approach stresses collaboration, path dependency, and an evolutionary perspective of innovation systems (Nelson, Winter, 1982). Various industries have evolved through international collaboration and, subsequently, the attractiveness of a location is dependent on how well it can interact globally. For instance, the Japanese automotive industry started to actively build strategic alliances as early as the late 1980s (Fujimoto, 1999).

The discourse on the competitiveness of nations initially focused on the development of science and technology. Porter (1990), rightly, emphasized that this is not enough. There is a need for national innovation policies. Based on extensive research on how the transition from an industrial age to a knowledge economy paradigm influences competitiveness and how this affects national innovation policies, Cooke and De Laurentis (2010) note that the winning bid in large complex projects is often provided by a constellation of interacting firms from different nations. This suggests that as globalization and the knowledge economy increase complexity, the need for different forms of collaboration also increases. This calls for a new perspective on national competitiveness and innovation policy, anchored in a deeper understanding of how knowledge is developed.

Fagerberg et al. (2015) argue that economic stagnation, climate change, and the governance crisis are closely inter-related and impact European innovation policy-making in many ways. They believe this requires a fundamental transformation of the economy to a new 'green' trajectory, entailing developing strongly selective policies to promote innovation in all its forms. They see innovations as not primarily scientific breakthroughs, but more defined by continuous experimentation, learning, gradual improvements, cost reductions, and increased performance of technologies that are already on the table. Their main argument, in respect of the future of innovation policies, is that climate change should be the most important macro-trend setting the direction for future innovation environments.

The findings of Cooke, Fagerberg, and their colleagues show that innovation processes differ depending on the industrial context and that the priorities for innovation policy setting are continuously changing. In the biotechnology sector the major innovation platforms have emerged around leading universities, whereas in the ICT sector such platforms are formed by individual companies (Cooke et al, 2010). For a national government to support the formation of attractive innovation environments, it must have a thorough understanding of the path-dependency and sector-specific characteristics of the actors to be activated in the formation of the environment and represents a major challenge. Lazzarini (2015), based on an analysis of how the Chilean government had supported the development of the mining and fishing industries, suggests that industrial policy can create firm-level competitive advantage in three ways: insertion of firms in global production networks, leveraging geographical specificity, and improving governmental capability.

Against this backdrop, the following will address the types of attractive innovation environments and whether there are context specific circumstances, which would indicate what types of innovation environments could be naturally nurtured in Finland.

Attractive innovation environments in the literature

The notion of an 'attractive innovation environment' is quite new and seems to have primarily evolved in the Nordic countries. The first ones to use this notion were Hedkvist and Weissglas, who in 2001 used the notion in the following context:

> *A well-functioning regional, national and international network between different actors in the society is said to promote the establishment of an attractive innovation environment.*

Raunio and Sotarauta (2005) in turn presented the following view on an attractive innovation environment:

> *An attractive innovation environment should include possibilities for individuals to create global, social and professional networks, image creation processes (partially through these networks), specific services for specific target groups, and so on. The creation of attractiveness is a process that develops the key facilities of the local innovation environment, and by doing so links it with key networks on the global level through organizations and individual persons.*

More recently Region Skåne in Sweden has defined a vision for its innovation strategy as becoming Europe's most innovative region by 2020. The way to realize this vision is described as follows (Skåne, 2011):

> *By means of regional, national and international collaboration, Skåne can develop into an attractive innovation environment. The foundation of the strategy is substantial investment in reinforcing Skåne's innovation culture and capacity. A culture which grows out of the creativity, openness and diversity that we have in Skåne today, while also supporting the development of new cultures such as social innovations and social entrepreneurship.*

Pustovrh (2014), when analyzing how open innovation impacts the growth strategies of small and medium-sized companies, suggested that large corporations are increasingly creating their own ecosystems that spread across several countries. These ecosystems and innovation networks interact with other networks, such as regional and national innovation systems. In an area of innovation globalization, a key role of an attractive national innovation environment is to provide linkages and entrepreneurship. Establishing the conditions for companies to benefit from the changes in the global organization of innovation activities thus becomes a critical success factor for national innovation policymaking.

The increasing openness of innovation systems has been addressed by a multitude of researchers. As early as 2008, the OECD argued that global innovation networks significantly influence the innovation systems of countries and regions. Three characteristics were highlighted (De Backer et al., 2008):

- The eco-systems or networks of innovation of multinational enterprises (MNEs) often represent the nodes between regional/national systems of innovation across borders and, as such, MNEs link between high technology start-ups, universities and research institutes, science and technology researchers, innovation intermediaries, and government institutions, across different countries.
- Through their distributed networks, MNEs aim to maximize agglomeration economies across countries by combining the transfers of tacit knowledge within local knowledge residing in national innovation systems (i.e. among innovation actors in local communities) with more codified knowledge through global pipelines or communication channels.
- These international R&D activities, including the integration in local innovation networks in host countries, are expected to positively impact the competitiveness of MNEs' activities in their home countries because of the existence of reverse technology transfers.

From the above we can identify preliminary attributes that characterize an attractive innovation environment:

- A well-functioning regional, national, and international network for enterprises and individuals; linkages to various national and regional innovation systems
- A culture of creativity, openness, diversity, entrepreneurship, and social innovation
- Conditions for companies to benefit from changes in the global organization of innovation activities.

The preliminary attributes of an attractive innovation environment, as identified here, do not, however, answer how these attributes impact the innovation dynamics of a specific business sector. All characteristics listed above are processual in their nature and do not, as such, pay any attention to the actual substance knowledge of a business sector.

While globalization and digitalization imply important new dynamics in innovation activities, path dependency and the evolutionary nature of innovation systems are still relevant considerations in innovation policy-making. This suggests that the present literature explicitly addressing the notion of attractive innovation environments is insufficient in providing guidelines for the development of policies to increase the attractiveness of an innovation environment. Based on the observations by Cooke and De Laurentis (2010) that innovation processes differ depending on

the industrial context we must deepen our understanding of the underlying characteristics of the variables that differ between various industrial contexts, in order to be able to make recommendations of which industrial contexts would seem most suitable for Finland as candidates to become future attractive innovation environments.

Nurturing innovation environments

In his overview of economic development, innovation systems, and innovation policy Fagerberg notices that it is an only relatively recent phenomenon among economic theorists to pay attention to innovations in addition to scientific underpinnings. The first attempt to distinguish between invention and innovation was made by Schumpeter, who also made the first definition of innovations: new combinations of existing sources of knowledge, capabilities, and resources, not all of which may reside within the firm. This recognition that innovations often require collaboration between multiple actors led to the development of a system approach to innovation (Freeman, 1987, Lundvall, 1992, Nelson, 1993). This in turn gave birth to the term 'national innovation system' introduced by Freeman in 1987. Before that the term innovation policy had been introduced by Professor Roy Rothwell of the Science Policy Research Unit (SPRU) at the University of Sussex in the UK, who had described innovation policy as the fusion of science and technology policy with industrial policy. (Fagerberg, 2016a)

Innovation systems are also beginning to attain the attention of companies. Historically, companies rarely perceived themselves as agents of social change. Today, two drivers are encouraging companies to interact with the public sector to promote social progress. Firstly, the legitimacy of business is increasingly questioned, forcing large corporations to take more social responsibility. Secondly, many of the world's most challenging problems create new markets in themselves, which cannot be addressed without close collaboration between the public and the private sectors. Subsequently, businesses must take a system view and participate in multisector coalitions to address issues such as climate change and an ageing society (Kramer, Pfitzer, 2016).

Innovation networks increasingly crossing national borders, implying that the notion of a national innovation system has, in many cases, been replaced by the notion of a technological innovation system, which are defined as a set of elements, including technologies, actors, networks, and institutions, which contribute to the development of a particular field of technology (e.g. a specific field of technological knowledge or a product and its applications) (Bergek et al., 2015). For a new technology to succeed it needs to overcome a multitude of challenges including addressing blocking mechanisms. Market formation can be blocked by an absence of standards (which leads to a fragmented market) while poor awareness and insufficient capabilities among potential customers or ecosystem partners can imply poor articulation of demand. Subsequently, innovation policies should aim to remedy poor functionality in the innovation system, or system failure, by strengthening/adding inducement mechanisms and weakening/removing blocking mechanisms. A specific policy instrument can't, however, be assessed in isolation, but a holistic perspective on innovation policy is required. (Bergek et al., 2008)

Even if the notion of a technological innovation system compensates for some of the shortcomings of the concept of a national innovation system it still leaves a number of issues unaddressed. The key questions are, how do the functional requirements of the innovation system evolve in pace with the maturation of the technology, how to address the transition between the formative and growth phases of a technology field, and how to conceptualize the interactions between a technological innovation system and its context. (Bergek et al., 2008)

Like national innovation systems, the notion of technological innovation systems does not address the particularities of a specific business sector. Consequently, the analyst must have a thorough understanding of industrial dynamics, which includes a more than superficial grasp of the technologies involved and draws on insight from many disciplines. This is necessary to understand the significance of interactions with complementary innovation systems, infrastructure, and of couplings of a technological nature where the focal innovation system may benefit from the knowledge base and products generated in other innovation systems. (Bergek et al., 2015) This implies challenges in providing practical guidance for supporting innovation in business sectors by using conceptualizations of innovation systems, which are defined as agglomerations without clear ownership.

Lall (1992) approached the issue of how governments can intervene to strengthen technological and industrial development in a somewhat different way. He noticed that traditional neoclassical economic theory assumes that innovation is a completely distinct activity from gaining mastery of a technology or adapting it to different conditions. He argued that this approach disregards the peculiar nature and costs of technological learning in specific activities and this calls for the use of evolutionary theories (Nelson, Winter, 1982) to understand the asymmetries among firms in terms of their technological capabilities. In the same fashion, Pitelis and Teece (2016) argued that business firms are the engines at the very center of a private enterprise economy (Nelson, 1981; Winter, 2016), and that innovation policy should recognize that the competitive advantage of a firm within a nation does not necessarily lead to a competitive advantage for the nation.

From the firm's point of view, there is little difference between efforts to improve technological mastery, to adapt technology to new conditions, to improve it slightly, or to improve it very significantly – though in terms of detailed strategies, degrees of risk and potential rewards, these efforts will certainly be different. The firm must possess some core operational capabilities relating to operating efficiency, product design, marketing, supply chain management, and overall coordination to compete effectively in open markets. This basic core must grow over time as the firm undertakes more complex tasks. From an innovation perspective, the ability to identify a firm's scope for efficient specialization in technological activities—to extend and deepen these with experience and effort, and draw selectively on others to complement its own capabilities—is the hallmark of a "technologically mature" firm (Lall, 1992). These abilities are like the dynamic capabilities of a firm: sensing, seizing, and configuring (Teece, 2009). Subsequently a technologically mature firm is one which possesses strong dynamic capabilities.

Development, which concentrates exclusively on market-driven incentives, on the one hand, or on capability-building measures, on the other, is apt to be misleading. It is the ***interplay*** of all these factors in particular country settings that determines, at the firm level, how well producers learn the skills and master the information needed to cope with industrial technologies and, at the national level, how well countries employ their factor endowments, raise those endowments over time, and grow dynamically in the context of rapidly changing technologies (Lall 1992). Pitelis and Teece (2016) further expand this line of reasoning by arguing in line with Krugman (1992) that strategic trade policies in support of certain sectors and firms could favor a nation that employs them. They suggest that public policy measures should be designed to strengthen selected industrial sectors, either directly and/or through impacting on supporting and complementary activities and sectors / business ecosystems. This implies that states can help create and co-create markets and wider ecosystems, thereby co-creating the transition space within which public, private, and social activity take place. The efficacy of the co-creation process depends on a comparative, advantage-based division of labor between public-private and the polity (aka third sector). Importantly all three require dynamic capabilities to foster system-wide sustainable competitive advantage (Pitelis, Teece, 2016).

The role of the state is not in "picking winners". Strong firms, with well-developed dynamic capabilities, are in a better position to produce that outcome. But government itself can possess dynamic capabilities that allow it to help create and co-create a supportive macroeconomic, institutional, and business context (Pitelis, Teece, 2016) by leveraging geographical specificity, inserting firms in global networks, and exposing governmental capability (Lazzarini, 2015). As Lazzarini arrived at his conclusions from a case study of the industrial policy of the Chilean government, we could generalize his suggestion that the government can support the establishing of attractive innovation environments through the support of:

- Resource provision (based on the comparative advantage of the nation and specific locations/sites),
- Market co-creation (domestically and internationally), and
- Orchestration and capability building.

How resource provision, market co-creation, orchestration, and capability building interact to form an attractive innovation environment must be understood on the level of a business sector.

The elements of an innovation environment

Bergek et al (2008) have noticed that there are different types of networks within an innovation system, some orchestrated and other networks evolving in a less orchestrated fashion including for example buyer-seller relationships and university-industry links. It is therefore necessary to better understand how complementary institutions influence capability building and identify the requisite governance structures that can help reduce any negative externalities (Mahoney et al., 2009).

The emergence of new technology fields takes place in transitional networks. Gustafsson (2010) has found that both public research organizations and firms are crucial for a new technological field to emerge. Three main stages distinguish how a new technology field emerges: mobilization, structuration, and commercialization (Wallin, et al. 2012).

To understand the dynamics of evolving technology fields and clusters it is relevant to make a distinction between "collectively" developed and maintained networks and those that are clearly orchestrated by one organization. Collective networks can be defined as value constellations (Normann, Ramírez, 1994, p. 54):

> ***Value constellations*** *are formed by enterprises coming together to co-produce value and allocate the tasks involved in value creation among themselves and to others, in time and space, explicitly or implicitly.*

Ecosystems in turn link one particular firm's competences or resources to those of other firms in order to draw on a broader range of competences. Such extended networks of firms can be defined as business ecosystems (Teece, 2009, p. 16):

> ***Business ecosystems*** *are communities consisting of organizations, institutions and individuals that impact the nodal enterprise and its customers and suppliers.*

Both value constellations and business ecosystems are ***meta-organizations****, organizations whose agents are themselves legally autonomous and not linked through employment relationships but have a common system-level goal* (Gulati et al., 2012). Value constellations are architected, but have no orchestrator, whereas a business ecosystem is both architected and orchestrated (Wallin, 2006, Laamanen, Wallin, 2009).

The emergence of an ecosystem involves three structural processes, (i) entry of firms and other organizations during mobilization to form value constellations, (ii) formation of networks during structuration, and (iii) institutional alignment once growth is established in the commercialization phase. The final stage of institutional alignment requires a process of structured knowledge accumulation during the transition which enables competitive ecosystems to exploit the potential of the innovations (Bergek et al, (2007).

Historically, innovation policy making has focused on the resources of the innovation environment. However, there has been limited attention paid to how these resources form a systemic entity and how the actors interact when exploiting the resources. Neither has there been a focus on how markets are created and shaped. One reason for this disconnect between the policy making discourse and the practice of management is the limited understanding of how the maturity of the business context and the business-sector-specific requirements imposed upon the innovation process should guide innovation policy making. In the following we will illustrate how the increased complexity of innovation processes call for a more holistic view on the interplay between resource provision, market co-creation, and capability building. We will also argue that, due to the increasing demands on a broad view on innovation, the issue of capability building is becoming more and more important.

Resource provision

Barney (1986) suggests that a firm may gain exceptional advantages from resources that are valuable, rare, inimitable, and non-substitutable. When exploiting its own resources, the firm may need to use external resources. Firm resources can thus be divided into firm-specific and firm-addressable resources. Firm-specific resources are those which a firm owns or tightly controls. Firm-addressable resources are those which a firm does not own or tightly control, but which it can arrange to access and use from time to time. Firms use resources to provide offerings to markets (Sanchez, Heene, Thomas, 1996).

Examples of resources that the innovation environment can provide to a company include human resources, physical resources, knowledge resources, capital resources, and infrastructures including networks of various types. The relative importance of different types of resources differs widely among industries. A nation's firms gain competitive advantage if they possess low-cost or uniquely high-quality resource of the particular types that are significant to competition in a particular industry. (Porter, 1990)

The system approach to innovation (Edquist, 1997) recognizes that the degree to which the resources of the innovation system can be exploited varies across nations, and government interventions are made in order to address system failures. Examples of failures include infrastructural failure, transition failure, lock-in, institutional failure, network failure, and capability failure (Woolthuis et al., 2005).

When providing resources to the innovation environment, governments need to consider the structural components of the innovation system, i.e. the

- actors (firms, universities, research institutes, interest organizations, venture capitalists, organizations deciding on standards, etc.),
- networks (informal as well as formal such as standardization networks, technology consortia, public-private partnerships, university-industry alliances, etc.), and
- institutions (culture, norms, laws, regulations, routines) (Bergek et al., 2008).

It is important to note that the functional pattern of an innovation environment or an innovation system differs across business sectors and is also likely to change over time. In any new, emerging organizational field, the resource development requirements will change as the field moves from mobilization, through structuration, towards full commercialization. This indicates the need to closely relate the issue of resource provision that of market formation.

Market co-creation

Innovation environments are increasingly characterized by complex interdependencies and multiple kinds of interactions between the various elements of the innovation process. This also requires attention to the demand side, to evaluate the role in public policies for innovation of demand-side instruments such as public procurement, incentives, and regulation. Public procurement also involves interaction and learning processes that use other kinds of information. Edquist and Hommen (1999) notice that, during the phase of market formation, there is a need for both users and producers to maintain broad access to information about product capabilities and user needs respectively. The quality of such information can be improved by consensual regulation, or by incentives provided by innovation policies, e.g. in the form of technology programs. However, there is a risk that establishing such intermediate knowledge structures can later become sources of inertia and resistance to change. Thus, in periods of radical change, governments might need to transform many of the estab-

lished user-producer relationships that are supported by vested interests and stimulate the formation of new user-producer relationships (Lundvall, 1988).

Market creation becomes a major concern for innovations within fragmented market settings. Research on the relationships between networks and market creation has shown the importance of an entrepreneur, embodied in a focal organization, in market creation. While collective learning often depends on networks, networks without focal organizations are likely to remain in "a low-level equilibrium trap". An organized articulation of demand is necessary to resolve coordination problems involved in market creation. Concentrated demand exercised by an entrepreneurial focal organization can engage a core of innovative users sufficiently large to dissolve the "trap". (Teubal et al. 1991)

The challenges in market creation require extraordinary capabilities on behalf of the focal organization, orchestrating the network in respect of the co-ordination of the activities within the network and the direction of the joint activities. The focal organization must perceive the need, identify the necessary ingredients, secure the resources that are needed, and communicate the shared vision to the other actors in the network. In many cases, the focal organization must be a major business firm, having the capacity needed for the extensive resource mobilization (Edquist, Hommen, 1999).

Edquist and Hommen (1999) summarize that there are different types of market formation, which put different requirements on innovation policy:

- Technology based innovations traditionally focus on product markets and product innovation, innovation policy should recognize complementarities among firms and seek to coordinate their efforts through creation of "chains of innovation" involving linkage structures among firms and other actors;
- In distributed innovation processes, there are different actors involved in the process, notably lead users, and here the state can take the role of a lead-user and apply innovative public procurement as a means of speeding up market creation;
- In periods of rapid change, user-producer relationships may have to be reconfigured and the innovation policy can support the transition by establishing new innovation programs that would make organized markets conducive to innovation;
- With new emergent technologies, there may be a need to establish a focal organization providing vertical linkage between users and producers to overcome a "low-level equilibrium trap" calling for the involvement of public agencies in market creation to form a core of innovative users sufficiently large to overcome problems of otherwise inadequate critical mass;
- In situations of extremely complex technologies and where demands for resources and influence are large, the public sector may have to initially play the role of the focal organization to successfully overcome the problems of critical mass by forming a large-scale framework for interactive learning.

When the potential innovation represents a considerable challenge to overcome its "liability of newness" the role of institutions becomes particularly important. The innovation must be legitimized to gain social acceptance and compliance from relevant institutions (Bergek, et al., 2008). To do this, one needs to deeply understand the "path-dependence" of social patterning in innovative behavior and the role played by organizations, norms, rules, and laws (Edquist, Hommen, 1999). Often an innovation will meet competition from adversaries defending existing practices and the institutional frameworks associated with them (Bergek, et al., 2008).

Capability building

In the 1990s, capability development emerged as one of the major areas of strategic management research (Teece et al. 1990, 1997; Helfat, 1997; Eisenhardt, Martin, 2000). Firms develop their capabilities in both proactive and reactive ways. They both create new sources of competitive advantage and imitate competitors to 'catch up' to their more advanced competitors (Cockburn et al. 2000; Raff, 2000; Karim and Mitchell, 2000). Successful firms actively identify, interpret, and act upon early signals from their internal and external environment and, in so doing, position themselves to effectively exploit these opportunities well in advance of others' demonstration of the pay-off from the strategies which later emerge as 'best practice'. These firms are *creating* new sources of competitive advantage (Cockburn et al., 2000, p. 1142).

There is yet very limited empirical evidence of how a firm can interact with the regional or national innovation system to enhance its capacity to innovate and achieve global competitiveness (Yam et al., 2011). One exception is the research by Caloghirou et al. (2004), which showed that both firm innovation capabilities and openness towards knowledge sharing are important in bolstering innovation performance, and that interaction between the firm and external actors may prove beneficial in two ways: first, in establishing channels which embed knowledge flows, and, second, in allowing organizational knowledge creation. This suggests that the public sector can support innovations by enabling joint capability building with the firms engaged in innovation activities in business sectors supported by the public sector. This has been further accentuated by the increased rate of globalization and digitalization whereby

companies are forced to constantly look for new ways to reap benefits from changes taking place in the environment. Subsequently, companies must strengthen both their ordinary and dynamic capabilities (Teece et al., 1997, Winter, 2003), or evolutionary learning capabilities, which are related to higher order system changes that are rather irregular and infrequent, and often connected with rare, episodic, and unique historical events (Fuijimoto, 1999). The competition requires the creation and co-creation of clusters and ecosystems in particular locations (Pitelis, 2012).

Jarzabowski (2008) suggests that the public sector can integrate its innovation strategy with the daily activities relating to the services that are provided to citizens and organizations. One way is to engage with external stakeholders and citizens in learning communities or knowledge alliances. This involves direct interaction with various organizations and individuals to nurture a discussion about the future performance criteria and administrative procedures.

The role governments can play when nurturing an innovation environment depends on both the collaboration logic within a business sector and its maturity. The public sector may, during the very early phase of market formation, share some of the risks related to the needed trials and experimentation and trigger activities that would otherwise not be undertaken by firms.

Integrating the value creating activities with capability building through knowledge alliances implies that the capabilities become both the medium for the network to constantly transform itself, as well as the embodiment of the competitiveness of the innovation network. This can be facilitated by providing innovation platforms, which offer opportunities for firms and other stakeholders to engage in shared value creation and contribute to capability building. Co-creation thus becomes the *modus operandi* as no single organization has all the necessary knowledge, skills, and resources. For the participating firms, the ultimate objective is to access resources from multiple sources when driving co-created value through global networks (Prahalad, Krishnan, 2008). When ecosystem members run into areas of competition, the government can be a mediator that will enable the process to be carried forward through a clear division of responsibilities (Cooke et al., 2010).

For a government to succeed in its role as an agent of change in the innovation system it must establish institutional recognition as a legitimate actor in the innovation network. Two criteria for success can be identified to achieve the necessary position of legitimacy: the quality of human resources and the inclusion in networks of international co-operation with similar institutions. This will enhance the possibilities for firms to co-operate with other firms and with research institutions in networks, enhancing systemic innovation capability (Fiore et al., 2011, Mulgan, 2013).

Subsequently, when building capabilities for market co-creation there must be a comparative, advantage-based division of labor between the actors involved in the process. Bottleneck assets and capabilities need to be identified and leveraged in the context of specialization. By acting as a "public entrepreneur" a public-sector actor can be critical in co-funding the requisite research and disseminating the knowledge needed for small and medium sized enterprises to establish a presence in the emerging ecosystem. (Pitelis, Teece, 2016)

The long-term sustainability of a company or a business ecosystem depends on how strong its dynamic capabilities are. Dynamic capabilities are the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets (Teece, 2007). Pitelis and Teece (2016) have noted that companies that generate new, signature processes (Gratton, Ghosal, 2005) possess superior dynamic capabilities. They also suggest that market creation, and co-creation, is the dynamic capability par excellence, the mother of all dynamic capabilities.

Dynamic capabilities thus resemble Honadle's (1981) definition of governmental capability. Honadle's and Teece's capability definitions can be combined by seeing governmental capability as the ability to anticipate and influence change, guide future actions (i.e. sensing), make informed, intelligent decisions about policy; develop programs to implement policy (i.e. seizing); attract and absorb resources; manage resources; and evaluate current activities (configuring). These dynamic capabilities are critical capabilities needed by a public actor to support innovations in an increasingly global context. A key challenge for any public actor nurturing innovations is, therefore, how well it is able to develop such dynamic capabilities.

The dynamic capabilities integrate, build, and (re)configure internal and external competences to address rapidly changing environments (Teece, 2007). Dynamic capabilities typically involve long-term commitments to specialized resources and the ability to sustain a particular patterned development approach depends, to some extent, on continuity in the personnel involved (Winter, 2003). Prioritizing capability development calls for the categorization of capabilities. There is a systemic interdependence between the dynamic and ordinary capabilities. Ordinary 'zero-level' capabilities are those that permit an organization to survive in the short term, whereas dynamic capabilities are those that operate to extend, modify, or create ordinary capabilities (Winter 2003). Corporate culture is a special underlying, facilitating capability category and can support or restrict the development of ordinary and dynamic capabilities, but is difficult to change in the short to mid-term, due to stickiness (Szulanski, 1996) and cognitive restrictions.

Mission-driven innovation; the Danish wind energy sector[1]

A tendency towards a shifting emphasis from industrial process efficiency to focus on sustainability can be identified in the way the innovation policies have evolved in the United States. There is a gradual shift from an initial focus on process excellence, towards a more complex understanding of excellence, including also offering excellence, innovation excellence and societal excellence.

A detailed analysis of the evolution of the wind energy sector in Denmark shows that the development can be characterized as an orchestrated effort to create an attractive innovation environment, with the Danish government, and the Test and Research Centre in Risø, being the orchestrator responsible for achieving the objective of reaching the 10 % target, set by the Danish government in 1981, of electricity produced by wind energy in the year 2000. Service-led sectors supported by green technologies ("cleantech") call for complex solutions forcing companies, governments, and citizens to collaborate for a new sustainable organizational field to emerge. We can identify three distinct phases in the emergence of a new field: mobilization, structuration, and commercialization. In the following we will illustrate how the government can influence and steer the emergence of a new organizational field though the case of wind energy in Denmark.

Mobilization

The Danish Windmill Owners Association (DWO) was instituted as early as 1978, to interact with politicians to create a regulatory framework and interact with other stakeholders to bring the wind turbine sector forward. This took place only one year after the Danish government had launched its three-year Wind Power Program in 1977. The strong involvement of activists and users has distinguished the Danish wind sector from the very beginning. Another important feature of the Danish system was the emergence of the Risø Test and Research Center as the knowledge hub of the whole innovation system, which was legitimized in the late 1970s.

The government also made its ambitions clear, by stating in the 1981 national Energy Plan that the goal was to have 10 % of Danish electricity produced by wind energy in 2005. This was supported by offering 30 % investment subsidies for wind turbine buyers and inviting utilities to become part of the management of the Wind Power Program. Early on, the Danish government also initiated close contacts with international counterparts, carrying out joint tests with American researchers on the Gedser turbine during the years 1977-1980. The results were quite encouraging right from the start. 170, relatively small, wind turbines were built between the years 1976-1979, and several companies actively started to build up specific wind turbine capabilities, among them Vestas and Bonus.

Structuration

The 1980s were characterized by a high level of activity in the global wind community, largely driven by the Californian subsidies for wind turbines, leading to a boom in the market. The Danish government responded to this by providing support for a market study in 1982. The results were encouraging and exports rapidly increased, reaching the volume of 2,000 turbines exported in 1985. However, the market also quickly contracted and, in the aftermath, the period of 1985-1987 saw a large number of Danish wind companies enter bankruptcy. As the demand from the US disappeared, the Danish government agreed to provide a project financing scheme of 750 million DKK to enable Danish manufacturers to compete for wind turbine contracts in Asia and Europe.

Inspired by the American example, the Danish government approved the first feed-in law in 1984, giving wind energy producers 85 % of the consumer price when connecting their turbine to the grid. In addition, a new investment subsidy program for wind turbines was also introduced. The subsidies had several conditions, one being that the investor had to live within a radius of 10 km from the turbine, supporting a distributed development model, whereby innovations were carried out in parallel in many different places. Furthermore, this approach also resulted in a large part of the population becoming involved in the wind movement and thereby improving the image of wind power among the citizens. This was particularly important in the 1990s when siting problems started to become a concern and made the expansion of wind power more difficult.

The cooperation between the government and the utilities was formalized in the 100-MW agreement formed in 1985. The objective of this agreement was to install an additional 100 MW of wind energy by 1990.

Commercialization

The new technical approval and certification procedure established in 1991 stipulated that every wind turbine erected in Denmark had to be of a type approved by the Test and Research Centre in Risø or by another institution authorized by the Danish Energy Agency. This cemented the position of Risø as the knowledge hub within the Danish wind turbine innovation system and secured the continuation of strong coordination among the different activities in the Danish wind cluster. A new area which also gained a lot of research attention was offshore wind and the first off-

[1] This section is based on Wallin, G (2014)

shore 5 MW wind park was developed by Elkraft and Bonus in 1991. The Wind Turbine Law established in 1992 updated the feed-in law established in 1984. The installed base grew from about 500 MW in 1992 to 2,300 MW in the year 2000, when wind energy represented 18 % of the Danish electricity consumption.

Denmark has also been successful in keeping a central position in the international wind turbine sector. The leading Danish company Vestas employed over 15,000 people in the year 2013, and had a turnover of more than €6 billion. Siemens, which acquired Bonus in 2004, has maintained significant R&D functions in Denmark. The future of wind energy is however affected by the increased demand for coal due to reduced coal prices. Subsequently, the Danish government is actively promoting a stronger European backing of renewable energies on the EU level, and sees the EU ETS as an important tool to secure continuous support for renewable energy. This was explicitly stated in the Danish Climate Policy Plan published in 2013. The formation of the Danish wind energy sector is summarized in the following table.

The formation of the Danish wind energy sector.

Activities	Resource provision	Orchestration	Market co-creation
Oil crisis, 1973		New energy policy by Danish government	
Anti-nuclear grass roots movement, 1974			User communities; OOA, OVE
Wind resource research, 1975		Finding ways to exploit the wind resources in Denmark	
Riisager windmill, 1976	Danish Electrical Utility Association; permission	Connecting the wind turbine to the grid	Market established; Møller first customer, 50 turbines sold 1976-1980
Wind Power Program, 1977-1980	National wind atlas for all of Denmark	Research on large-scale turbines; quality standards and certification principles	Utilities joining the Wind Energy Program
Danish delegation to the US, 1977	U.S-Danish research cooperation in wind	Danish-US test program supervised by US DoE	
Tvind Folk School, 1975-1978	Helge Pedersen one of the designers	2 MW turbine, 54-meter down-wind rotor	Symbolic importance
Danish Windmill Owners Association, 1978-	Statistics on individual turbines; easy access to users for manufacturers	Natural Energy magazine; monthly wind meetings, experience sharing	User community; Møller active member (first meeting at his house)
Risø Test and Research Center, phase I; 1978-	Resource for firms, continuation; pilots	Help develop wind turbines for industrial production	Helge Pedersen becomes the director
Market formation; 1976-1979	Ten firms actively selling wind turbines, Vestas, Bonus etc.	R&D subsidies of $5-10 000 evaluated by Renewable Energy Committee	About 170 wind turbines erected 1976-1979
Steering through monitoring; 1975-	Collaboration with the Renewable Energy Committee	Danish Energy Agency interacting with other stake-holders in the wind sector	
Investment subsidies; 1979-	Co-operation between manufacturers and Risø mandated	Create production opportunities for Danish industry; approval by Risø	30% investment subsidy for private buyers within three kilometers
Energy Plan; 1981	Envisaged that there would be a need for 60,000 small turbines	Providing a vision and direction for the further development of the wind energy sector	Wind energy should contribute 10 % of electricity by 2005; legitimation, important for utilities
Market growth; 1981-	Local user-producer networks	Local ownership stimulating local development	Local acceptance of wind mills; less siting problems
New quality principles; 1982; Risø central actor	Components should be dimensioned twice the norm	Risø as the common test, consultancy and R&D department; knowledge node	Danish turbines more sturdy and reliable than competition
US exports; 1982-1986	2000 turbines sold to the U.S. in 1985	Subsidy for U.S. market study in 1982	California first export market
Investment subsidies; 1984-	Rapid growth in employment	Stimulating the attractiveness of wind energy as energy source	40% investment subsidy for privately-owned wind parks
Feed-in tariff; 1984	Tariff of 85% of electricity consumer price; ten years	Stimulating the attractiveness of wind energy as energy source	Utilities paid 35% of the costs of connecting to grid
Results; 2000	Leading producers: Vestas and Bonus	18 % of Danish electricity generation was wind power	Wind power capacity about 2,300MW

A Strategic Innovation Initiative

Garud and Karnøe (2003) suggest that the Danish regulators have been able to 'modulate' the growth of the industry with policies flexible enough to rectify temporary undesirable outcomes. The confluence of the learning processes resulted in co-shaping of the actors and artifacts constituting the emerging technology path. This resulted in the blurring of boundaries between design and production, planning and executing, rule-making and rule following. In this respect, the formation of the ecosystems of e.g. Vestas and Siemens was supported by the actions taken by the government. Thus, the Danish government has not only supported capability building, but indeed taken the role of orchestrator at various critical stages of the evolution of the wind energy sector. This has been based on clear value creation and value capturing objectives of the government, in addition to facilitating the general capability building activities within the sector. We will here call such a development a ***Strategic Innovation Initiative***, which is a systemic effort to drive innovation by simultaneously considering resource provision, market co-creation, and capability building through purposeful orchestration.

The Danish wind energy sector has developed in a highly transparent way and the citizens have been very engaged in the innovation activities, particularly in the early stages in the 1980s. This was also recognized by Kamp (2002) who notes that the Danish wind turbine sector received far less support from the government than that of the Netherlands. However, in Denmark the involvement of users was much stronger than in the Netherlands. She suggests that the fact that the users organized themselves and issued a monthly magazine and organized wind meetings stimulated learning and benefited the turbine manufacturers too. The early turbine users were farmers and small companies in favor of wind energy. This created trust and a common mindset with the turbine producers. The researchers at Risø also shared the same vision regarding wind energy. In this way, they supported the step-by-step learning and the interaction between turbine producers, turbine users, and the researchers became one of the main reasons for the Danish success (Kamp, 2002). The government also had good insight into the state of the wind turbine market thanks to the central position of the Risø Test and Research Center. In this way, the orchestration of the industry was, to a large extent, handled by Risø, in this particular case.

Two parallel capability building paths can be identified. Through the decentralized structure of the early phase of the development of the wind energy sector, incremental development of the technical capabilities relating to turbine technology took place in several locations in parallel. This was mainly the responsibility of the private sector. Meanwhile, the Risø Test and Research Center's role as the testing and approval body enabled a centralization of the accumulated knowledge, which contributed to the development of the dynamic capabilities on a central level being in the hands of the public sector. This development utilized different tools on both supply and demand sides to steer and guide the evolution of the sector. With the objectives already stated explicitly in 1981, to source 10 % of the electricity produced from wind energy by the year 2005, it was also easy to engage different stakeholders around the common objective. In this respect the evolution of the Danish wind energy sector was clearly a mission-driven undertaking, which was initiated with the ambition to contribute to societal excellence.

The Danish wind sector started off from the ambition to achieve societal excellence. The four excellence elements (process, offering, innovation, and societal excellence) were all developed in parallel. Excellence in each element can be identified in retrospect, but this was the *ex post* outcome of the market co-creation process wherein the various stakeholders participated in different roles as the development proceeded. As of today, process and offering excellence can be identified in the manufacturing competitiveness of Vestas and Siemens Wind Power, innovation excellence is still maintained by the two-layered development. Risø Test and Research Center is now part of Technical University of Denmark, but maintains a strong position as the wind energy competence center. Simultaneously, continuous development is taking place on the local level, where the utilities work together with the turbine manufacturers particularly on innovations in the offshore wind sector.

The investment subsidies in the 1990s increased the interest among utilities to engage in the development and added resources to the system. A positive feature of the Danish system has been the relatively low degree of lobbying against wind power, even if the siting problem temporarily slowed down expansion. Also evident is the continuous technological progress, whereby the Danish manufacturers have maintained their leading position globally. This was illustrated by e.g. the January 2014 announcement that Vestas was switching on its first 8 MW offshore turbine at the Danish National Test Centre for Large Wind Turbines.

In addition to strong domestic support, the Danish wind turbine manufacturers have been actively pursuing export business since the early 1980s when they first entered the Californian market. In this respect the Danish manufacturers have developed a good global overview of the wind turbine market and are able to flexibly shift emphasis from one market to another one when demand fluctuates.

Architectural considerations of attractive innovation environments

The resources embedded in social relations among people and organizations that provide a common language and trust, and facilitate collaboration among the individuals engaged in a value constellation, form the social architecture of the innovation environment (Wallin, 2006). Perlmutter and Trist (1986) suggest that the formation of symbiotic partnerships is needed to mitigate the long-term threat of environmental degradation and enable social transition. Genuine interdependence should be selective and reciprocal to harmonize the need for growth with the requirements of the environment. In this world, the role of the nation-state would diminish, some powers would be transferred to larger units, other to smaller units so that a multilevel system would be brought into existence. The ambitions of both the U.S. national innovation system and the Danish wind energy sector have been to form an innovation environment characterized by a social architecture of symbiotic partnerships.

When considering the role of the operational architecture it must be recognized that the national state, the place (city or region), and the companies all interact. As argued earlier, the role of the country is diminishing. However, when technology is a dominant factor and the public sector itself is a major customer, like in transport, energy, social and health care, and education, the country level continues to remain important, and public procurement can speed up innovation. But companies, when selecting the locations for their innovation activities, are increasingly considering specific places, cities, or even city districts. The interplay between the different geographical layers is illustrated in the figure below (strengths in blue, opportunities in red).

Based on the figure, one can see that the national innovation system is under pressure from two directions. Firstly, innovation activities are increasingly imposed upon a country by global firms, which do not always follow the same rules as the incumbent organizations. The numerous lawsuits against Microsoft, Google, and Uber illustrate this. Secondly, the need for citizen engagement in the innovation activities additionally requires strong local innovation environments, which seem to be particularly relevant in activities aiming at addressing societal challenges (Fagerberg, 2016b), illustrated e.g. by electric cars in Norway, and particularly in the city of Oslo (Fagerberg et al., 2016). However, the field of competition is rapidly changing in many sectors. Therefore, Uber, for example, initiated a public relations campaign, in autumn 2016, to improve its public image to be better positioned when demonstrations of autonomous vehicles do start.

Cities such as Barcelona have raised their profiles as innovation leaders, where the 22@Barcelona city district has been marketed as a place for "smart city" development, and Malmö, which has positioned the Western Harbour area as a leading example of a densely built urban environment. In these cases, the innovation environment is a result of interactions between the city, companies, and citizens. The role of the national government is rather limited. Companies active in these environments bring in new knowledge to the area based on their international experience and offer possibilities for local companies to leverage their networks for internationalization, if successful local collaboration is established. However, establishing such collaboration is a challenge. The public sector can help to overcome these challenges by supporting the necessary capability building. In the development work the access to resources (e.g. universities, research institutes, NGOs, etc.) and lead users to

Roles and architectures for an attractive innovation environment.

	Country	Place/Site	Company
Societal architecture	• Legislation, legitimation and procurement	• National support (financial, ideological)	• Opportunistic and pragmatic (good or bad)
Service systems	• Engagement agreements	• Demonstrations	• Orchestrated ecosystems
Enabling technologies	• Knowledge repositories	• Public-private-people partnerships	• Disruptive technology

support market formation are important. The objective is to enable orchestrated ecosystems that will generate growth and jobs based on the demonstrations. Through various forms of incentives (e.g. subsidies, training arrangements, logistics infrastructures, etc.) and legitimation, a national government may increase the quality of the needed local engagement agreements.

If the role of the operational architecture is to secure dynamic decision making, allowing for continuous upgrading of the capabilities in the ecosystem, the information architecture provides the situational awareness, which is needed for value creation, capability building, and ecosystem orchestration (Wallin, 2006). The information architecture is the architectural layer wherein the biggest changes are taking place at the moment. The companies leading the digital revolution have based their business models on establishing an information architecture, which is carefully designed in respect of open and proprietary characteristics. It has even been argued that data is the new oil. Although companies like Google, Facebook, and Amazon have open-sourced artificial intelligence software, allowing any programmer to access their code and use it for further development, they are not making their proprietary data available. The disruptions are not based on technology but on deep learning. It is the data these companies possess that is more valuable than the software tools they use and release to the public. IBM has estimated that only 20% of the world's information is stored on the Internet, while the other 80% is privately held within companies and organizations (Varian, 2016).

Appendix 2. Country benchmarks

In the following, we will present reflections upon how benchmarked countries (Sweden, Norway, the Netherlands, Belgium, and Japan) and their national or regional innovation agencies have addressed the issue of attractiveness of their innovation environments.

All countries, except Norway, have about the same GPD per capita as Finland and are open, export driven economies. The countries can be divided into two groups in terms of R&D expenditure: the industrially strong Finland, Sweden, Belgium, and Japan, all have a comparatively high private R&D intensity (and a gross domestic R&D intensity over 2%). The Netherlands and Norway have rather low private R&D intensity (partly due to service and raw material based strengths), leading to a lower gross domestic R&D intensity (below 2%).

European innovation scoreboard scores for the analyzed countries (2016, except for Japan 2015).

	Finland	Sweden	Norway	Netherlands	Belgium	Japan (2015)
Human resources	136	144	118	114	108	
Open, excellent research systems	134	175	184	166	165	
Finance and support	156	145	116	135	102	
Firm investments	117	145	51	56	116	+++
Linkage and entrepreneurship	143	146	84	154	172	
Intellectual assets	129	131	56	112	88	+++
Innovators	113	122	75	103	108	
Economic effects	98	109	63	119	98	

Benchmarking of European Innovation Scoreboard results (2016 or 2015 for Japan) highlights areas for learning. Sweden and Netherlands are innovation leaders; Sweden excels on all indicator areas. The countries have higher scores on open, excellent research systems (with Norway on top). The Benelux countries excel in creating linkages and entrepreneurship. Despite lower R&D investments, the Netherlands has been able to gain clearly above average economic effects. Japan is leading in firm investments and intellectual assets.

Resource provision

A common thread among the countries is a focus on top quality human resources; increased or continued resource provision to universities, combined with joint agenda-development between research, public, and private actors in terms of new opportunities. Mechanisms vary between countries from the rather loose Swedish model to the stringent Dutch model. There is increased integration and collaboration across organizational boundaries. New expenditures are built to motivate further private R&D—without a clear role for SMEs. Key observations from the benchmark countries:

- All countries have strong research policies. The Flemish and Swedish policies emphasize university autonomy, also in Norway and Japan a sizeable part of the funding is non-earmarked. In addition, there are strong, mission or theme-driven research calls. Norway and Sweden have increased their investment in research. In Norway, the growth of published articles has been the fifth fastest in the world. In the European countries, the share of research institutes is on the way down. In Norway, based on co-developed expertise, the institutes have attracted international clients. Dutch public research institutes have succeeded in competing with universities, who also have a strong collaboration capability.
- Competence is emphasized; the Netherlands focuses on education in applied universities, Norway and Japan on higher education, Belgium states that it has the third best education system in OECD ranking, while Sweden has the highest human resource score in the innovation scoreboard.

- The share of private R&D has either peaked for now or decreased. Many of the countries have introduced tax deductions to motivate further investments. The Netherlands has made this a clear priority. The Dutch focus on developing favorable conditions for firms (instead of funding projects) is aimed at streamlining the regulatory framework, providing tax incentives for investments in knowledge and developing instruments to improve the availability of finance, combined with a top sector, co-governed approach, which motivates close networking and collaborative private-public-research projects. During the last funding period, Dutch higher education, research institutions, and the business sector also achieved the highest return in the EU.
- The Belgian system is the most region focused, with RDI decisions made at the regional level. Norway too, through its innovation cluster program, is strongly regional. Both Norway and the region of Wallonia have managed to avoid only building from present strengths. In Norway, the new openings are called Arena. The Belgian regional systems seem to have been able to address the needs of local SMEs and Norwegian cluster plans include a strong internationalization component.
- Strategic innovation agendas to address long-term opportunities and to systematically steer public and private R&D investments are developed in Japan and Sweden. In Japan, programs are managed in a cross-ministerial perspective, leadership is dedicated to either key corporations or universities. In a similar manner, the strategic agendas in Sweden have gravitated to issues with a focus on company competitiveness research areas (e.g. reindustrialization) or societal excellence (e.g. health).
- All countries are targeting SMEs and their growth, but the analysis does not yet include any results from the recently introduced startup ecosystem programs; e.g. in Japan and the Netherlands. In Sweden, despite weak public support, Stockholm has been able to churn out "unicorns", with a similar situation as in the Netherlands – where the tax credits and top sectors are not as well suited, particularly in serving startups. Belgium, according to the indicators, seems to excel in SME collaboration.

Market co-creation

Despite a recent stronger emphasis on market co-creation in the compared countries, the ambition level is still low, which can be seen in evaluations of both Challenge-drive innovation in Sweden and Innovative procurement in Norway. Japan could, through the SBIR-approach, pass the other countries, but, as of now, Sweden is a step ahead with the challenge-driven approach and its readiness for co-development across sectors. Key observations from the benchmark countries:

- During the post-war era, Sweden had close collaboration between the public sector and leading companies in lead markets. The current challenge-driven innovation program is, again, is concerned with co-solving challenges in the society, now in a more ecosystem oriented way, structured into evolutionary phases of collaboration, with the last phase being the demonstration of the developed solution. Sweden also aims to utilize the public sector more broadly as a co-solver of challenges to induce innovations. There are also showcases, e.g. in sustainability, with public-private collaboration and strong political support.
- Innovative procurement has been promoted systematically in Norway, both between public and private actors, but also e.g. between state-owned Statoil and other companies. To spread this type of innovative behavior the efforts need to be further stepped up. Sweden has recently also emphasized this opportunity. Public demand is used in the Dutch "top sector" model.
- The Japanese revitalization plan is market oriented–it focuses on both domestic creation of strategic markets and exploring global opportunities. In addition, the Japanese government promotes the introduction of a multi-stage selection method in "Small Business Innovation Research (SBIR)" as a system for bringing results of advanced S&T into commercialization. The government considers setting targets of a certain ratio or amount of the R&D budgets of the governmental ministries and agencies.

Orchestration and capability building

Japan and the Netherlands provide a high degree of portfolio/cross-sector level orchestration in selected strongholds, with defined structures and procedures. The other countries have a lower ambition regarding orchestration on project, region, or actor level.

- In Sweden, Vinnova states that the quality of the innovation system is raised both based on the MNEs' capabilities, but also because of their direct global contacts. In the Netherlands, eight MNEs stand for 76% of the R&D expenditure. In practice, the role of the Japanese global companies, such as Toyota or Mitsubishi, is central in orchestrating key mission-driven projects driving the national agenda.
- The KU Leuven case exemplifies how universities can assume the orchestrating role in life sciences, with a supportive architecture to nurture innovations.
- Japan and the Netherlands have a framework (in Japan, in the form of the Council for Science Technology and Innovation governed by the Prime Minster and, in the Netherlands, the "top sectors" model) for addressing global opportunities in terms of research, innovation, and industry. The Japanese model represents a process

dividing investment into two categories, mission-driven, and basic research, with distinct prioritization criteria. The Dutch "top sector" model provides the private-research-public-leadership teams with an opportunity to co-orchestrate the activities of a consortium and, simultaneously, promote a broader set of policies and funds (e.g. internationalization and investment promotion). Similar ambitions can be found in the Wallonian poles of competitiveness. In the Netherlands, the collaboration between universities and companies is well established and is extended towards including also citizens/customers as is exemplified by Eindhoven.

- The more regional systems in Belgium and Norway and a program-level Swedish approach provides opportunities for orchestration and capability building more in a bottom-up fashion. The Challenge-driven-innovation program in Sweden and the Norwegian Innovation Clusters illustrate this. The Norwegian Innovation Clusters have explicit responsibilities in terms of competence development.

The comparison of the five countries: Sweden, Norway, the Netherlands, Belgium, and Japan has shown that all countries are, to varying degrees, using all three elements of resource provision, market co-creation, and orchestration and capability-building in order to make their innovation environments more attractive. Providing resources to nurture innovations remains the main approach, but we can see that some countries, particularly the Netherlands and Japan, are actively building a more versatile portfolio of support activities to also strengthen the market co-creation activities.

It has been ten years since Esko Aho suggested that there was a need for Europe to provide an innovation-friendly market for its businesses and that this called for action on regulation, standards, public procurement, and intellectual property in addition to fostering a culture which celebrates innovation. Aho argued that a combination of supply and measures to create demand should be focused in large scale strategic actions, with an independent High Level Coordinator to orchestrate European action in each area (Aho, 2006). The Japanese Strategic Innovation Promotion Program with its Program Directors has largely implemented the recommendations put forward by the Aho report.

Sweden

The Swedish economy has performed comparatively well in European comparison during recent years. It has a population of 9.6 million, a 2015 GDP of SEK 4 181 billion (€430 billion), and a gross public debt of 44 %. In 2013, Sweden's R&D intensity was 3.2 % (0,9 % public + 2,3 % private).

The European innovation scoreboard in 2016 shows that Sweden is an innovation leader (within EU nr. 1, nr. 2 in Europe after Switzerland), but with a declining innovation performance since 2013. It is still performing above the EU average for all dimensions. In EU-comparison Sweden is leading in human resources and open, excellent and attractive research system and second in firm investments and intellectual assets. Sweden is especially strong in international scientific co-publications, public-private co-publications, license and patent revenues from abroad and PTC patent applications (in societal challenges).

Sweden – Innovation system morphology

The current R&D intensity is well below the peak level of 2001 (4.18 % of GDP). The downward variation is mainly due to changes in private sector R&D investments, the public R&D investments have been relatively constant at just below 1%, a comparatively low figure internationally. The private sector R&D investments are expected to decrease, as 2013 figures do not fully include the effect of the decisions of AstraZeneca and the telecommunications and electronics sector to reduce R&D activities in Sweden. (Vinnova, 2015)

The OECD Review from 2012 points out that Sweden has maintained an exceptionally broad range of products, based on a strong industrial base. The review pointed out, however, that important segments of Sweden's industry have been taken over by non-Swedish multinational enterprises with headquarters outside Sweden.

In Sweden the private sector is the main source of R&D funding. The private sector in Sweden had during several decades a competitive advantage through early internalization, in many fields co-operation between national industries and the state, as well as a framework for sharing productivity gains between different sectors. The virtuous cycle experienced by the earlier model and otherwise supportive conditions has supported Sweden into an enviable position in terms of private sector breadth and capabilities. The R&D expenditure by the private sector is rather strong in international comparison. The expenditure has however, been in decline, partly as a consequence of ownership and globalization related relocation of industrial R&D and partly as the SME's expenditure has shown a steeper decline. (Vinnova, 2015)

Business Sweden claims that Stockholm is second in the world (after Silicon Valley) when comparing billion-dollar-companies there are per million inhabitants. This in spite that Vinnova (2015) states that Sweden does not support in an international perspective much in new and small firms.

Public funds for R&D are mainly directed towards Higher Education Institutions (HEIs) or through research councils, public foundations or sectoral agencies, while the share

of public funding to private sector R&D has decreased. On the whole, public research institutes play a minor role with the exception of the area of defence, but are increasingly important as bridge builders between research and innovation and different actors. (Vinnova, 2015) The Ministry of Education and Research and the Ministry of Industry (in Sweden called Ministry of Enterprise and Innovation) are responsible for most of the public agencies and research councils financing research in Sweden.

In a report (for the Swedish research, innovation and higher education long term policy) Vinnova has seen that strong globally operating companies that Sweden has provides the Swedish innovation system a higher quality through the broad set of capabilities they possess, but also due to their direct contacts globally. Furthermore, Vinnova has seen that despite not being that successful in technology related sectors, Sweden has been exceptionally strong in internet-based service companies, which is a valuable asset.

Public sector activities are seen by Vinnova as an enabler for innovations. Challenges such as climate change, health and migration demand system wide solutions including both public and private sector inputs as well as the involvement of citizens and research. Vinnova has addressed this through a program on challenge-driven innovation as well as promoted public innovative procurement. Sweden has in international perspective a high quality of public activities as well as experiences of how the political processes have enabled system changes (e.g. early sustainable city districts; Hammarby Sjöstad in Stockholm and Västra Hamnen in Malmö).

Vinnova furthermore states that in order to benefit from the globalization Sweden has too fragmented structure, strategies and incentives in terms of international collaboration, especially from the public side. This will demand a re-positioning of firms and universities, joint strategic programs and public cross-sectoral collaboration. Otherwise the risk is that the present Swedish competences and activities in the future will be developed elsewhere than Sweden.

Vinnova continues that for Sweden to be attractive in the future it needs to engage actors that have complementary knowledge, competences and technology but also societal conditions that enable innovations to penetrate the market place. It furthermore concludes that despite a clear indication that increased dynamism can be achieved through R&D, and that there wold be a need to fund publicly R&D to get more radical innovations, Sweden provides very limited public funding for new and small companies.

Despite a strong economic growth rate and the fact that Sweden ranks high in most country rankings of competitiveness and innovation, the Swedish innovation system shows also surprising weaknesses. The innovation system was evaluated by OECD in 2012 and the SWOT-analysis presents an innovation system with broad and multiple areas of strengths, good opportunities that can be attained through collaboration, weaknesses especially in issues that affect the competitiveness on longer term (i.e. innovation policy, financing, university activities linking to commercialization and education) and threats mainly related to risks of complacency due to the present good situation.

Sweden – Research focus

The main research funding agencies are:

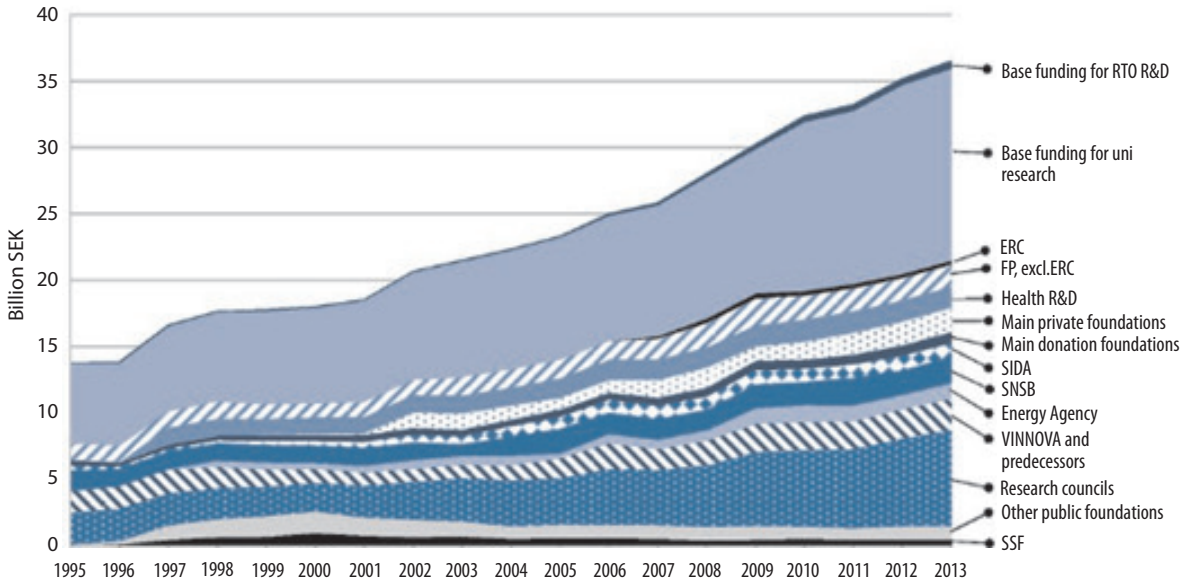
- the Swedish Research Council which in 2014 funded about SEK 5,5 billion to basic research in natural sciences, technology, medicine, the humanities and social sciences.
- Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) funded about SEK 1,12 billion in basic and needs-driven research in the fields of environment, land-based industries and spatial planning.
- Swedish Research Council for Health, Working Life and Welfare (Forte) distributed SEK 512 million in basic and needs-driven research in the fields of the labor market, work organization, work and health, public health, welfare, the social services and social relations.
- The Swedish Governmental Agency for Innovation Systems (VINNOVA) funded about SEK 2,4 billion in needs-driven research in the fields of technology, transport, communications and working life.

Of other agencies with important roles, but with lesser roles in research, in the funding are e.g. Swedish Energy Agency and Swedish National Space Board. Together these six agencies provided 85% of government R&D funding in 2014. These research councils also operate independent of each other, which means that a specific research group may receive funding from several sources over time. (Vinnova, 2015)

Swedish universities have a strong core funding from the state, enabling them a long-term focus in their strategic research. This has been boosted by two recent bills (2008, 2012). Sector research (towards needs of industry sector) is to a large extent carried out in the universities. Basic and research council funding have not only been historically important, but have lately grown in importance. (OECD)

An interesting comparison between Finland and Sweden can be seen in the 2014 Stora Enso announcement that it will concentrate its new biomaterials business development in an Innovation Centre in Stockholm area. StoraEnso has opened a similar centre in Helsinki, focusing on packaging. The Swedish center will be focusing on research on e.g. lignin and sugars, while the Finnish center is to use a more rapid innovation model.

Main sources of funding for R&D, innovation and demonstration available to Swedish actors in billion SEK.
(Source OECD Review of innovation policy Sweden, 2016)



When comparing research funding six major universities (Lund, Uppsala Universities, Karolinska Institutet, Chalmers, Royal Institute of Technology and Linköping University) took 77% of the funding. (Vinnova, 2015)

The output of Swedish research (according to OECD, 2016) seems to have stagnated – the system produces good research – but not enough excellence. Öqvist and Berner explains that one of the reasons is that Sweden fails to focus on top-class science or nurture top talent. Also the linkage between universities and private sector is seen to be in need of strengthening.

To focus research on synergetic areas and strengthen collaboration between universities and industry Vinnova initiated Strategic Innovation Programs in 2013. The objectives were to renew positions of strengths across sectoral borders. The first 16 programs can be divided into four groups based on their point of departure:

1. Global firms in engineering and basic industry and their reindustrialization. Includes digitalization, resource and environmental efficiency and development of new materials (technology leading to decreased use of energy and raw materials).
2. Enabling technologies. Includes Internet of Things, technologies in electronics and photonics, smart electronics systems and graphen.
3. Development of societal functions. Includes health care and transport systems.
4. Societal transformations. Includes bio-economy (forest materials based), products and services to replace fossil raw materials, resources efficiency and digitalization in construction sector.

(Vinnova, 2015)

The 2016 OECD review shows how programs initiated since the 2012 review (Strategic Research Program, Strategic Innovation Program and Challenge Driven Innovation) have succeeded in working on some of the recommendations, but points out that lack of adequate governance leadership and strategic vision is at the heart of many of the difficulties encountered in successfully implementing the policy initiatives. Challenges include e.g. the lack of strategic choices and investments by universities (due to weak internal governance), and a lack of national visioning mechanism to steer research and innovation policy.

Norway

Norway has a population of 5.2 million, a 2015 GDP of $ 388 billion, and a gross public debt of 21,7 %,. In 2014 the R&D intensity only 1,71 % (of which less than half is from private sector).

The European innovation scoreboard in 2016 shows that Norway is a moderate innovator, performing below the average form most dimensions and indicators, and with a declining innovation performance since 2011. Large performance declines have particularly taken place in community designs (-15%) and license and patent revenues from abroad (-10%), in these dimensions it is also performing particularly below EU average. On the other hand firm investments have grown, particularly into non-R&D innovation expenditure (13%). Norway is in EU-comparison very strong in international scientific co-publications indicator and in general in open, excellent and attractive research systems. Despite the low performance on the innovation

scoreboard, Norway enjoys above average economic effects in e.g. employment in knowledge intensive activities and exports of knowledge intensive services. Norway research council has concluded that the international scoreboards have not been able to portray the innovations developed based on raw-materials industries.

Norway – Innovation system morphology

"We live off what we find in nature" is a common refrain in Norway, and Norway has indeed both refined raw materials, but also developed advanced capabilities around the resources; e.g. deep-sea drilling, aquaculture, bio-refineries… Norway enjoys natural resources like oil and gas, marine resources, surplus of emission-free hydropower and forest resources. As a result Norway has the second highest GDP per capita in Europe, highest labour productivity in the OECD and the world's biggest sovereign wealth fund. This wealth is historically very recent, and the rise to the present position has taken place from 1970's onward. (The Economist, 2013)

Norwegian industry has traditionally preferred to buy services from the Public Research Organizations rather than investing heavily in internal R&D. This pattern was strengthened with the rapid growth of the Norwegian oil and gas industry, and the derived demand for knowledge and expertise, from the 1970s onwards, giving rise to an expansion (and reorientation) of the Norwegian PROs to meet the needs of the new industry. Up to 30-40% of the raw material industry firms report cooperating closely with PRO's. The PRO's also benefit from the way tax-credit for R&D is organized. (Fagerberg, 2012, 2016)

The Norwegian success in raw material based industries has been complemented by a continuous strive to develop a more knowledge-based economy, but the relative success of the raw materials based industries, particularly Oil & Gas has siphoned much of the educated engineering talent and even the innovation policy until recently has mostly been geared towards natural-resources based sectors (Fagerberg, 2012). For instance investments into greener R&D have had a mixed result; on one hand these investments were halved in industrial sector during 2009-2013, on the other hand in EU framework programmes environmental and energy related research is an area where Norwegian research groups have a strong specialization and impact. (NRC, 2015).

The success of particularly oil & gas and related sectors seems to have created a mental lock-in for many actors in the country, this despite the warning signals for over-dependence through recent falling oil prices and lessened demand for Norwegian off-shore talent, and the Paris Agreement on carbon emissions. (Fagerberg, 2016)

Private sector in Norway has in international comparison a large state ownership. Norway's national oil champion, Statoil, is the largest company in the Nordic region. The Norwegian state owns large stakes in Telenor, the country's biggest telephone operator, Norsk Hydro, its biggest aluminium producer, Yara, its biggest fertiliser- maker, and DnBNor, its biggest bank. It holds 37% of the Oslo stock market, but it also controls some non-listed giants such as Statkraft, a power-generator, which if listed would be the third-biggest company on the stock market. (The Economist, 2013).

The public sector has collaborated in an innovative procurement National program for supplier development since 2010. The motto has been "Future oriented public clients – future oriented suppliers". This far 40 projects have been undertaken. In a recent evaluation report (Menon, 2016) it was concluded that the activity as such had been successful, but it should be further scaled up. Another recommendation was to look at even more ambitious programs, such as SBIR in the US or SBRI in the UK as an example.

To support collaboration Innovation Norway, Siva and Norwegian Research Council have an regional innovation cluster program consisting of Arena (for immature clusters; 3-5 years), Norwegian Centres of Expertise (mature clusters, with a national position, 10 years) and Global Centres of Expertise (mature clusters with a global position, 10 years program). Currently 3 clusters have global centre status (all related to offshore and oil: Blue Maritime, Subsea and Node), 14 a national centre status and 22 Arena status. The strategic focus areas are: General cluster development, Knowledge collaboration, Innovation collaboration and Cluster-to-cluster collaboration.

Norway – Research focus

Central actors and funding schemes in supporting R&D&I are:

1. Government tax credit for R&D is in budgetary terms the largest among the government's innovation policy instruments towards private sector – but it is not very widely used. (Fagerberg, 2016)
2. Innovation Norway, despite its name, is supporting a much broader (mostly primary industries) and less innovation focused portfolio of development activities (Faberberg, 2016). The main policy tools are support to projects and loans. Innovation Norway is owned by the Ministry of Trade, Industry and Fisheries (51%) and the county authorities (49%). (Innovation Norway)
3. Norwegian Research Council's (and its innovation division). Policy tools are targeted programs project support, e.g. Center of Excellence program, through which 21 university driven centers receive a funding for a 5+5 years period. The research council is a major funder of the higher education and institute sector. The council also funds some thematically oriented programs for industrial sector as well as user driven innovation. (Norwegian Research Council)

4. Other government funding; including ministries budgets, mainly for university and institute general funds. An important actor is Siva, which is a public enterprise owned by the Norwegian Ministry of Trade and Fisheries. (Norwegian Research Council, S&T report 2015)

The public major allocations for R&D comes from Ministry of Education and Research, 15 billion NOK, out of a total 30,4 billion NOK. Other ministries with more than 10% allocations of the total is the Ministry of Health and Care Services and Ministry of Trade, Industry and Fisheries. The structure of the Norwegian system of education, research and innovation presents the other key ministries involved in innovation. (Ibid.)

The R&D expenditure by the private sector is 20,4 billion NOK and is mostly used for internal R&D and to purchase services from institute sector. Most of the R&D expenditure from abroad is utilized similarly, investments by foreign owned companies into R&D by companies in Norway and purchases from research institutes. (Ibid.)

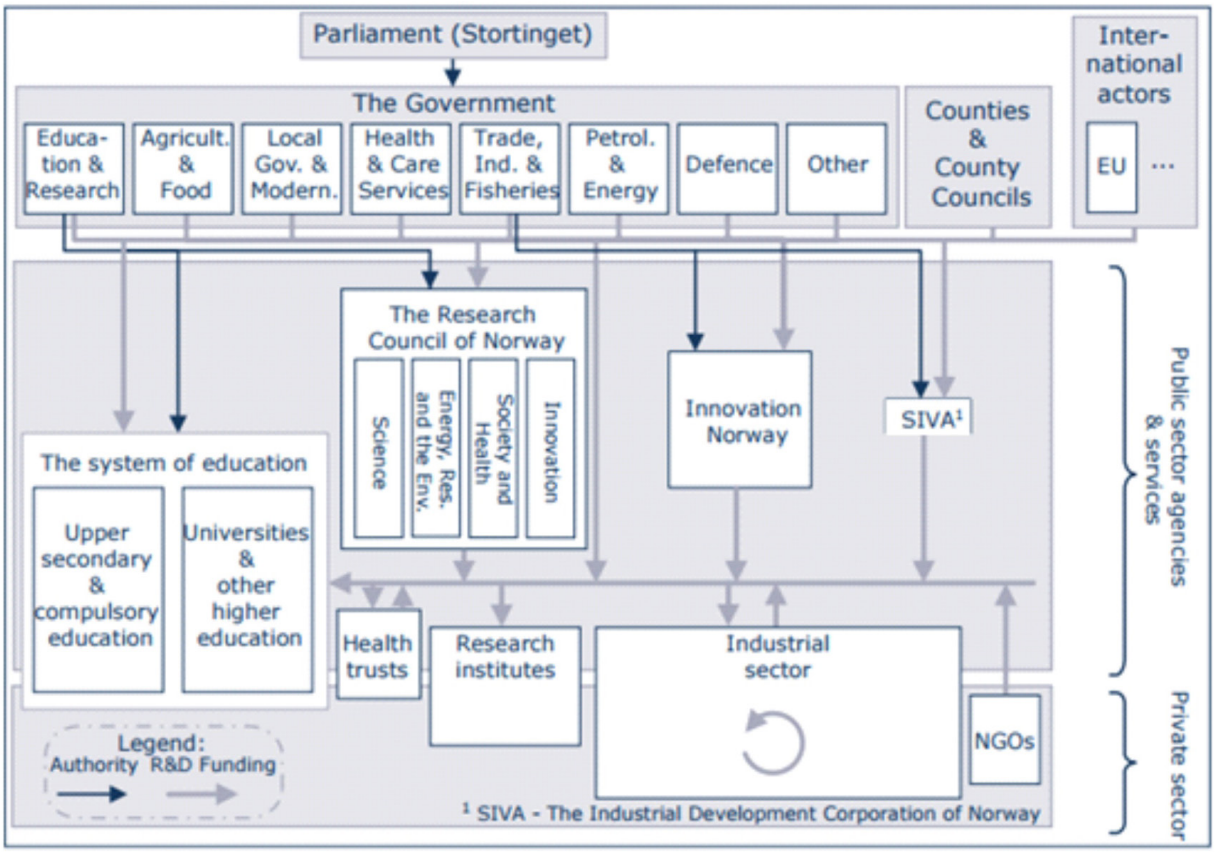
Of the total expenditure of R&D higher education sector accounted for 32% (out of which university hospitals 5%) and the institute sector 24%. Institute sector can be divided into two parts – clearly more company service oriented research institutes and government serving institute, of which the latter is bigger. The higher education sector has had a double growth rate (4% annually) in comparison with the institute sector. (Ibid.)

Eight universities carry out 80% of the higher education R&D, of these institutions the sought after ERC-funds were received by University of Oslo (22 scholarships 2007-2014), University of Bergen (9), NTNU (8) and University of Tromsö (3). There is clearly a positive dynamic in research - in an international perspective Norway has had the fifth strongest growth in production of scientific articles between 2006-2014 (after China, South Korea, Australia and Denmark). (Ibid.)

Norway has a strong specialization in earth sciences and technology. A sharp increase in the earth sciences´ share of the Norwegian articles is the most significant change in Norwegian academic profile since the 1970s. This is clearly due to Norway's emergence as an oil nation. Among other disciplines within natural sciences and technology, we find a strong specialization in environmental sciences and technology and biology. (Ibid.)

The specializations can be seen in FDI. According to Innovation Norway China had invested until November 2015 more in Norway than in other Scandinavian countries. This has taken place first and foremost through acquisitions of companies like Elkem, REC and Awilco, all representing the

Norwegian system of education, research and innovation. (Source: Norwegian Research Council, S&T report 2015)



Total R&D expenditure in Norway by funding source and sector of performance. (Source: Norwegian Research Council, S&T report 2015).

Sector of performance	Total	Industry			Government				Abroad	
		Total	Industry and other	Oil companies	Total	Gov. excl. Research council[1]	Research council of Norway	Other sources[2]	Total	Of which: EU-commission
Industrial sector	22,557	17,918	17 918	..	934	509	425	653	3,052	99
Institute sector	12,190	2,467	1 944	523	7,965	5,138	2,827	445	1,313	444
Of which Research inst. Serving enterprises	4,079	1,746	1 381	365	1,535	543	992	203	596	224
Health trusts and private non-profit hospitals[3]	698	10	10	..	658	651	7	30	1	1
Research institutes serving government sector	7,413	712	554	158	5,773	3,944	1,829	213	716	219
Higher education sector	16,001	660	500	160	14,183	11,712	2,471	718	440	323
Of which Univerity hospitals	2,772	45	45	..	2,560	2,404	157	138	29	19
Total in Norway	**50,748**	**21,044**	**20 362**	**683**	**23,082**	**17,360**	**5,723**	**1,817**	**4,805**	**865**

[1] Includes grants from Innovation Norway.
[2] Includes private funds, own income and SkatteFUNN (tax deduction for R&D).
[3] Incl. private/non-profit hospital regional with health authority agreement.

Source: Statistics Norway/NIFU, R&D statistics

energy sector and acquisitions of leading capabilities. Other sectors targeted have been hotels, beverage and ICT (e.g. Huawei greenfield) In total the investments have accounted for 5,45 billion USD..

Norway has a higher share of population with higher education than average in both OECD, EU and Nordic countries. (Ibid.)

In the Government Long-Term Plan for research and higher education 2015–2024 the thematic priorities are clustered around six areas:

1. Sea
2. Climate; Environment and green energy
3. Renewal of the public sector and better and more efficient welfare, health and care services
4. Enabling technologies
5. Innovative and adaptable businesses
6. World-leading experts.

Thematically the most important R&D areas in 2013 were health and care, 12 billion NOK and petroleum research, 5,7 billion NOK. (Ibid.)

The Netherlands

The Netherlands has a population of 16,9 million, a 2015 GDP of 752 billion $ and a gross public debt of 68,9 %. In 2013 the R&D intensity was 1,96 %. The private sector has R&D spending of 8,3 billion $, just over half of the total R&D spending.

The European innovation scoreboard in 2016 shows that the Netherlands is an innovation leader, with performance above the EU average for most dimensions, except for Firm investments, because of poor relative performance in Non-R&D innovation expenditures. It has excellent performance in License and patent revenues from abroad, International scientific co-publications (highest growth), and Public-private co-publications. Comparatively weak has been Non-R&D innovation expenditures (highest decrease) and Community designs.

The Dutch monitoring and evaluation policies are according to OECD extensive and sophisticated by international standards.

The Netherlands – Innovation system morphology

Netherlands is one of the most advanced economies in the world, with a tightly integrated role in the global economy and a favourable geographic position (e.g. reflected in the importance of Rotterdam, Schiphol). Consequently the Netherlands is the second largest exporter in EU in gross terms. As the service sector is a key strength in the economy, i.e. transports and logistics (re-export of goods), financial and business services, and has a comparatively low R&D spending - this lowers the intensity. On the other hand Netherlands has a very high rate of patenting activity (concentrated to top ten firms), and is a home to world leading multinationals, of which top eight; Philips, ASML, Shell, Royal DSM, NXP Semiconductors, Unilever, Océ Technologies and KPN/Gentronics contribute to 76% of Dutch private sector R&D expenditure. (OECD)

The Netherlands aims at being among the top five knowledge economies globally and has a strong university sector. Around 22% of the work force contribute to R&D, design, software, databases and other knowledge intensive activities, and the country is an innovation leader in EU and a pioneer in innovation policy. (Ibid.)

The current innovation policy rests on two main pillars – providing framework conditions conducive to innovation

for all business and the top sectors industrial policy. The government's effort to provide favourable conditions focus on streamlining the regulatory framework, providing tax incentives for investments in knowledge and instruments to improve the availability of finance. The top sector approach aims to identify market and government failures that prevent the sectors to achieve the full potential (i.e. innovations that eventually will lead into export performance) in international competition, and is to its nature a holistic and systemic.

The top sectors, initiated in 2011, entails a new form of governance – top teams are composed of high-level representatives from industry, public research and government. The top team task is to develop draft knowledge and innovation agendas for government. Based on a government evaluation and decision it commits to support top consortia for knowledge and innovation (TKI) formalised plans. The governance approach also includes a one-stop-shop service for the top sectors (including education, investment and trade promotion) and aligning multiple purposes of funding for the top sector approach (e.g. other ministries, sub-national authorities, EU co-funding. The current top sectors are: horticulture and propagation materials, agrifood, water, fife sciences and health, chemicals, high tech, energy, logistics and creative industries. The selected industries accounted for 80% of business R&D. The foreseen investment annually in 2013 was almost 2 billion €, of which 970 million € to companies in the top sectors. (OECD)

The innovation system SWOT-analysis by OECD in 2014 provides a two conflicting images

1. An innovation system with broad and multiple areas of strengths and good opportunities that can be attained through new approaches and practices, but
2. Weaknesses especially in structural and longer term perspective (e.g. lagging productivity, low R&D expenditure of industry, frequent innovation policy changes) and threats in the inability of making use of the potentials (e.g. low R&D intensity, utilization of rich human capital) in the face of global competition (Netherlands has not benefited from emerging markets as much as other EU countries, only 5% of gross exports go to BRICs).

The Netherlands – Research focus

The public research funding comes from i) government block grant, ii) funding from research councils and iii) contract research. The main research funding agency is NWO (The Netherlands Organization for Scientific Research). NWO funds public research, especially universities, funding areas are curiosity-driven research and talent, thematic research and public-private partnership, international collaboration, large research facilities and national institutes. KNAW (Royal Netherlands Academy of Arts and Sciences) is both a learned society (knowledge sharing and advisory for Dutch Government) and an organisation of national research institutes. The technology foundation, STW is a smaller agency, focusing on knowledge transfer from researchers to users. (OECD)

The main support for private sector is tax credits. The emphasis on tax credits vs. direct innovation support is stronger than in most other OECD countries. The government's earlier two separate tax arrangements for R&D will be brought into one scheme that will offset S&D tax credits against salaries tax and at the same time the funding will be expanded. In addition, the Innovation Box provides relief for licensing and commercialisation revenues, this program will also be renewed, with additional emphasis on actually conducting the research in the Netherlands.

During the 2007-2013 period the higher education, research institutions and the business sector succeeded in securing 3,4 billion € EU funding, which is the highest return in EU (1,5 times the Dutch contribution to budget). Universities are supported directly and firms through Netherlands Enterprise Agency (RVO) are supported both through funding programs and subsides as well as advisory on e.g. EU-programs

The two most active R&D&I ministries are the ministry of Economic Affairs and the Ministry of Education, Culture and Science, the other ministries are, however, involved through e.g. the top sector approach. (OECD)

The university system is strong – the universities both do well in international rankings, have a high number and quality of scientific publications and commercialization of public research (have strong links with public sector). There are 13 academic universities and the Open University. In the Times Higher Education list the top eight universities in 2017 are Delft University of Technology, University of Amsterdam, Wagenigen University and Research Center, Erasmus University Rotterdam, Leiden University, University of Groningen, Utrecht University and Maastricht University. All of these have a world ranking between50-100. The 37 universities of applied sciences have a more practical and professional focus and as 65% of the tertiary educated enrolments are to these universities, the high quality of the education is of central importance. (Ibid.)

The universities have already traditionally had a high emphasis on valorisation of research – i.e. process of creating value from knowledge; including commercialisation and academic engagement. Looking at the industrial funding of the university research (8,2 % in 2011 vs . OECD average of 5,9%) the Dutch approach of valorisation has produced good results. Three Dutch universities have higher share of industry co-authored papers than MIT and Stanford: Eindhoven, Delft and Wagenigen. (Ibid.)

Cities are also important actor in the collaboration; with a broader emphasis as shown by Eindhoven. Eindhoven was successful in harnessing the knowledge econ-

omy through its triple helix approach, bringing together industry, knowledge actors and local government. This was successful in the aftermath of the economic crisis of the eighties and early nineties when Philips and DAF shed significant numbers of jobs. The new Brainport Next Generation strategy means moving away from the Triple Helix model (where educational institutions work together with industry and government) to a Multi Helix model which also involves citizens, customers, consumers, investors, designers, artists, and corporations. The search is on for connections between technology, design, and social innovation, and also build bridges to other international knowledge regions that can help strengthen Brainport's position.

Research institutes importance has been decreasing. The share of industry funding in research institutes is higher than e.g. Finland and Norway, two other counties with comparatively high importance for PRI's. The institutes are highly fragmented, in total 26 institutes were provided funding in 2012 under NWO and KNAW, in addition to these government laboratories and applied research institutes form the entire group. The most important in terms of funding and government spending and employment were the applied research institutes; i.e. TNO, DLO and GTIs, which also will be affected by the top sector policy, as they have strong linkages with firms. (Ibid.)

Belgium

Belgium has a population of 11,3 million and a 2015 GDP of 454 billion $ as well as a gross public debt of 106 %. The national R&D intensity, in 2013 was 2,28 %. The gross expenditure in R&D was 11,7 billion $, out of which 6,7 billion $ was from the private sector. R&D activities were in 2010 concentrated in pharmaceuticals (28%), chemicals (9%) and computer services (8%).

The European innovation scoreboard in 2016 shows that Belgium is a strong innovator, with performance above the EU average, and especially for (SMEs) Linkages and entrepreneurship, but also in International scientific co-publications (research systems is the area that has improved the most). Relative weaknesses are in Intellectual assets and Economic effects.

Belgium – Innovation system morphologies per region

Belgian administration is strongly regionalized to Flanders and Wallonia regions and Brussels capital. The regions are competent in innovation policy and for matters related to persons including scientific research and education, including the higher education institutions. The federal role is limited to tax measures, intellectual property law, corporate taxation measures (R&D tax credit), employment legislation and social security. On national level there is also a coordinating office for federal science policy, key roles are managing the participation in the international programs as well as supervising federal research institutes

According to the Regional Innovation Scoreboard 2014, *Flanders* is ranked as an innovation follower, with a performance on EU average. Flanders has an on EU average R&D expenditure in the public sector, as well as in business sector. Flanders performs above average in terms of innovative SMEs collaborating with others, and in terms of SMEs innovating in-house. Innovation performance has improved over recent years, with an average annual growth rate 2004-2010 for innovation followers of 3.9%.

Flanders' Science and Innovation policy has not changed significantly in 10-15 years. The Government innovation policy is science and technology driven, concentrating supported research at Flemish universities, which have a strong autonomy in their choice of research areas. Strategic Research Centres (SOCs) are supported in five specific areas of strategic importance (microelectronics, biotechnology, energy & environment, ICT driven innovations and, recently, advanced manufacturing). The Flemish Co-operative Innovation Networks program (VIS) aims to stimulate technological innovation, particularly in SMEs, through financial resource provision for collective research projects, providing networking tools, raising awareness, and networking/matchmaking through competence poles. The founded competence poles were: Flanders MAKE (combining Flanders' Drive, automotive, and Flanders' Mechatronics Technology Centre; and the manufacturing department Sirris); Flemish Institute for Logistics (VIL);; Flanders' FOOD; Flemish Institute for Mobility (VIM); Flanders InShape (product development and industrial design); Flanders' Synergy (innovative labour organisation); Flanders' PlasticVision (plastic processing); Flanders Innovation Hub for Sustainable Chemistry (FISCH); the Social Innovation Factory. Of these, Flanders MAKE is the most significant, receiving €50 million in funding for the period 2014-2017 and aiming to support the growth of 500 small and large businesses.

Flanders also offers subsidies for projects in industry (R&D projects for companies programme, SME programme) as well as for 'strategic basic research' projects at universities (SBO and IOF). The government is committed to reaching the EU2020's 3% target for expenditure on R&D and will make an additional €500 million available for entrepreneurship and innovation policy from 2017 onwards. The government is expected to shift from science and technology based innovation policy to an entrepreneurship driven policy where companies, especially SMEs, will have a central position.

Flanders' expenditures on R&D reached 2.5% of GDP in 2013 (of which 1.7% privately financed, 0.8% publicly). In 2013, public and private R&D outlays represented a total of €5,827m of which 4,025m (69%) were business expendi-

tures on R&D (BERD) and 1,803m (31%) were public expenditures. In 2015 the Flemish government spent €1.46b on Economy, Science and Innovation, with €498m for scientific research and € 438m for innovation.

Wallonia invests in R&D are at par with the national average, private sector stands for 75%. The main industries are pharmaceuticals and chemical. From being an early industrial powerhouse Wallonia has as a region been playing catching up with more advanced region. In its innovation policy evolved from a purely industry sector or cluster based strategy to integrating sustainable development and investments into growing sectors (Marshall.2 plan) and further to integrating public and public resources (in research, investments, training, access to capital, etc.) and activities in competitiveness poles. The selection criteria for the poles has been to find booming and cutting edge sectors that have already demonstrated potential in order to build up a critical mass and a level of excellence. Presently the competitiveness poles are BioWin (Health), Wagralim (Agro-industry), Mecatech (Mechanical engineering), Logistics in Wallonia (Transport & logistic) and Skywin (Aeronautics & space industry).

Brussels R&D expenditure in the region was below the national average in 2011, amounting to 1.37%. The government sector represents a low share of R&D expenditure in the region, 0.13% GDP in 2011. The Regional Plan for Innovation presents an update of the regional innovation strategy in the context of the latest European and regional developments. With three fields of specialisation in health, ICT, and environment, the region puts smart specialisation at a high priority in the agenda.

According to the Regional Innovation Scoreboard (RIS 2014), the region of Brussels-Capital is ranked as an innovation follower since 2004 with an innovation performance below EU average. However, the progress has been relatively rapid in other EU regions. In comparison to the EU average, the region of Brussels-Capital performs particularly well as regards the level of education of the population, the level of employment in knowledge-intensive activities as well as for the share of SMEs innovating in-house and the share of innovative SMEs collaborating with other. The main longer term weaknesses in the region relate to the low level of public and private expenditures for R&D and innovation and the number of EPO patent applications. The updated Regional Plan for Innovation (2012) established five strategic objectives:

- Objective 1: Put smart specialisation at the service of the economy and employment (through strengthening of transversality, development of clusters and potential specialisation niches)
- Objective 2: Create a favourable environment for innovative companies
- Objective 3: Increase the attractiveness of Brussels as a European hub of knowledge
- Objective 4: Increase Brussels' participation in European programmes
- Objective 5: Strengthen the governance of innovation (monitoring and strategic analysis of innovation policies, evaluation, interregional cooperation).

Approximately 20% of the regional research and innovation support agency INNOVIRIS's budget is directed to thematic priorities. Moreover, half of its budget is used to fund enterprises, some 75% of which are IT companies, and the other half for universities/research centres.

Belgian authorities have made considerable efforts to support R&D activity, contributing to significant growth in R&D investment over the past 15 or so years, particularly in the field of chemical and life sciences. However, the government's policies have been criticized for a lack of clarity which has hindered development due to the limited scope of certain benefits as well as unnecessary bureaucratic complications and red tape.

Belgium – Research focuses per region

Flanders has five universities (incl. one Dutch language university in Brussels), four large strategic research centres (IMEC (merges with iMinds in 2016), VIB, VITO and Flanders Make) and a number of smaller competence poles and research centres for specific (mainly sectoral) knowledge development and distribution. With more than 39,000 researchers (full-time equivalent), the region gathers 65.5% of the researchers in the country in 2011. In 2014, 15,796 of these were university researchers. The share of R&D personnel in the total active population (1.39%) is higher than the national average (1.35%) in 2012. The business sector accounted for 70% of Flanders' R&D spending in 2013. Business R&D expenses in Flanders are mainly situated in high-tech sectors such as chemistry, pharmaceuticals, ICT, mechatronics, which together represent almost 80% of the total R&D expenses. The chemical and pharmaceuticals industry in Flanders alone represents 34% of total private R&D expenditures in Belgium (2013).

In terms of patenting, Flanders shows good performance: the number of EPO (European Patent Office) patent applications per million inhabitants in 2010 was 218.5. There is a strong concentration of patents in a small number of multinational companies. The main areas for Flemish EPO patent applications are chemistry, human necessities (including medical and veterinary sciences), electricity (including electric communication techniques), operations and transport, and physics.

In *Wallonia* the implementation of the policy in the Wallonia-Brussels Federation is placed under the Directorate General for non-obligatory Education and Scientific Research. The community has a dedicated public body in the National Fund for Scientific Research. Although most

of the decision-making is made in ministerial cabinets, the Walloon Council of Science Policy advises the government on science policy issues, strategies and on specific funding mechanisms. Wallonia counts no less than 9 university centres, 13 higher education colleges, 30 research centres, 6 university science parks dedicated to cutting edge technologies, numerous approved shared research centres and a wide "centres of excellence" network. In 2015 priority areas were spin-offs from universities, firm-university collaboration funding of research centres project and international collaboration. Also a cross-regional programme funding SME's was introduced in 2015. (Annual report of DG for non-obligatory Education and Scientific Research, 2015). The centres of excellence are structures pooling university research bodies, innovative start-ups, SME and large industrial groups. (Invest in Wallonia).

The role played by the government sector in the performance of R&D expenditures in the region of *Brussels-Capital* is low (0.13% of GDP in 2011). The two main universities located in the region are the Université Libre de Bruxelles (ULB), a French-speaking university with about 25,000 students in three campuses in the city (and two others outside), and the Vrije Universiteit Brussel, a Dutch-speaking university with about 12,000 students. In addition, the region hosts four other higher education institutes, three collective research centres (partly financed by industry) and a set of technology incubators. The share of R&D personnel in the total active population is considerably higher in the region with 3.08% in 2011 than at federal level. With more than 6,300 researchers (full-time equivalent), the region gathers more than 14 % of the researchers in the country in 2011.

R&D expenditures performed by the higher education sector represented 0.51% of GDP in the region in 2011.In terms of allocation of domestic expenditure between private and public sectors, business R&D expenditure in the region in 2011 represented 50.5% of GERD, while the higher education sector performed 36.9% of GERD.

According to a recent OECD study Belgium has the third best education system among the 35 OECD countries studied In Times Higher Education university ranking Belgium has one university in the Top 100, KU Leuven, and two other universities in the top 200, Ghent University and Université Catholique de Louvain. In a recent study by Thomson Reutares KU Leuven was ranked the most innovative university in Europe. The key metrics were research articles and patents. KU Leuven researchers submit more patents than almost any other university in Europe, and outside researchers frequently cite KU Leuven inventions in their own patent applications. Thomson Reuters also highlights the Flanders-based university's strengths in microelectronics, nanotechnology and IT, as well as its cutting-edge labs for virology and chemotherapy. "Our first place in the ranking is the result of years of unrelenting efforts, the creation of numerous spin-offs and the close-knit collaboration with companies", comments Koen Debackere, director at KU Leuven. (Reuters, 2016) An important facet was KU Leuven Research & Development (LRD) that was established in 1972 and was one of the first technology transfer offices in Europe. Within the university structure, a unique decision and incentive mechanism has been implemented. Researchers can form LRD research divisions, through which they can manage their technology transfer activities in an autonomous but supported way, and foster innovation and entrepreneurship in combination with high-level research and education. (Leuven – Life Science Pearl, 2013.)

Japan

After two decades of slow economic growth, Japan shows signs of renewed dynamism. It is the world's third largest economy in GDP terms after the United States and China, and with 3.35% of GDP dedicated to R&D it ranks among the world's most R&D-intensive countries. Growth prospects are clouded however by an ageing population, high national debt (over 230% of GDP), and the effects of the Great East Japan Earthquake. These growth challenges are also a major problem for Prime Minister Shinzō Abe, who also heads the highest innovation body in Japan, CSTI.

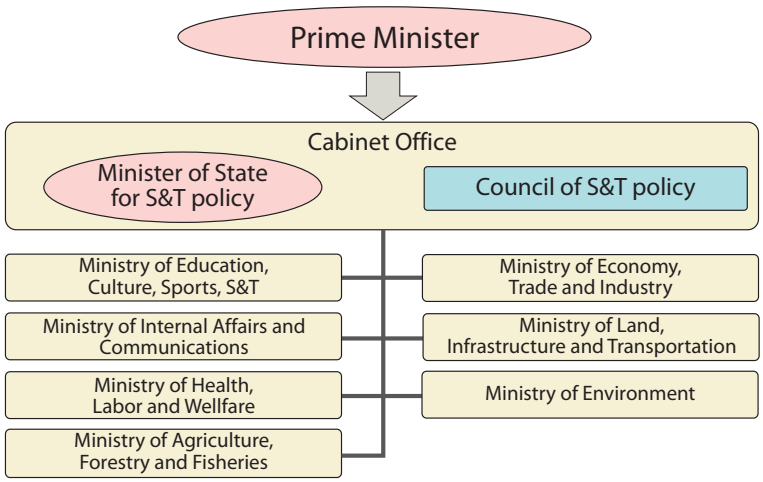
The Innovation Union Scoreboard 2015 compared EU with Japan, US and South Korea. Japan outperforms today EU with 14%, but reached a peak in 2008 and 2009 being almost 30% higher than that of the EU. Japanese businesses spend twice as much on R&D and Japan is also much more active in applying for patents. It is stronger in tertiary education. Japan also outperforms the EU on Exports of medium and high-tech products and License and patent revenues from abroad. Japan has relative weaknesses in Doctorate graduates, and a weakness as well as deteriorating status in International scientific co-publications, Most-cited publications and Exports of knowledge-intensive services.

Japan – Innovation System and research focus

Since 2001, the Council for Science, Technology and Innovation, CSTI (previously Council for Science and Technology Policy, CSTP), chaired by the Prime Minister, has had the leading role in developing overall Japanese S&T policy, including drafting and completing the S&T Basic Plans. The CSTI operates through a number of expert committees and working groups. The Bureau of Science, Technology and Innovation Policy in the Cabinet Office, with around 100 staff, serves as the CSTI's secretariat. CSTI is organized as shown on the following page.

The principles for allocation of innovation funds in the Japanese innovation system has a long tradition. This is based on distinguishing between two types of basic research: "Type-1 basic research that is conducted based on

The Council for Science, Technology and Innovation.



the free ideas of researchers in S&T, including human and social sciences; and Type-2 basic research that aims at future applications based on policies." The main significance of this distinction is that Type-1 basic research is considered to fall outside the system of thematic prioritization. In budgetary terms, about 40 percent of government expenditure on S&T was categorized as Type-1 basic research in 2009. This primarily included basic government funding of universities and bottom-up, peer review-based research funding. Thematic prioritization applied to just under half of central government expenditure on S&T. This part of the budget is labeled "Policy mission-oriented R&D". The remaining 10 percent concerns systems reform measures and other expenditure which cannot easily be thematically categorized. The breakdown of the 2009 government spending on S&T is illustrated in the following figure (source: Stenberg, Nagano, 2009):

The present revitalization strategy of Japan is based on three action plans: (i) Plan for the revitalization of Japanese industry, (ii) Strategic market creation plan, and (iii) Strategy of global outreach. CSTI then selects projects that answer critical social needs and offer competitive advantage to Japanese industry and the economy. This is promoted through the cross-ministerial Strategic Innovation Promotion Program. For each program there is a program director (PD) selected by invitation from among top-class leaders in industry and academy. Program directors break through ministerial silos, and manage programs from a cross-ministerial perspective. In 2016 there are 11 programs, whose program budgets represent about 1 % if the total innovation budget:

Prioritized Societal Issue	Theme	Program Director	Organization	Budget FY 2016 (Billion yen)
Energy	Innovative combustion technology	Masanori Sugiyama	Toyota Motor Corp.	1,9 (17 m€)
	Next-generation power electronics	Tatsuo Odmori	Mitsubishi Electric Corporation	2,3 (20 m€)
	Structural material for innovation	Teruo Kishi	University of Tokyo	3,7 (32 m€)
	Energy carriers	Shigeru Mukai	Tokyo Gas Co. Ltd.	3,5 (31 m€)
	Next generation technology for ocean resources exploitation	Tetsuro Urabe	University of Tokyo	4,6 (40 m€)
Next-generation infrastructures	Automated driving system	Seigo Kuzumaki	Toyota Motor Corp.	2,6 (23 m€)
	Infrastructure maintenance, renovation and maintenance	Yozo Fujino	Yokohama National University	3,1 (27 m€)
	Enhancement of societal resiliency against natural disasters	Masayoshi Nakashima	Kyoto University	2,1 (18 m€)
	Cyber-security for critical infrastructures	Atsuhiro Goto	Institute of Information Society	2,5 (22 m€)
Local resources	Technologies for creating next-generation agriculture, forestry and fisheries	Takeshi Nishio	Hosei University	2,7 (24 m€)
	Innovative design/ manufacturing technologies	Naoya Sasaki	Hitachi Ltd.	2,2 (19 m€)

The 5th Science and Technology Basic Plan, 22.1.2016

The Science and Technology Basic Plan must resonate with and be executed by those in the fields of research, development, and innovative initiatives. To maximize the potential accumulated from investments to date, universities must be reformed with the recognition that they contribute to society through their education and research, and partnerships between industry, academia, and government must be expanded. Additionally, working with the public will be promoted with the aim of transforming society through STI.

Executing the Fifth Science and Technology Basic Plan will require a wide spectrum of parties—including the government, academia, industry, and citizens—to work together. By executing the Basic Plan, we will grow the national economy and create jobs, secure safety and security for our country and citizens, make lives more prosperous, and contribute to global development.

As our economy and society matures, values are diversifying, with people's interests shifting from the tangible to the intangible. Rather than just seeking conventional technological innovations, users now demand new values and services to be created that resonate with their diverse needs.

Comparisons between the Japanese and Swedish innovation systems (Stenberg, Nagano, 2009)

The difference in scale and structure between Sweden and Japan makes comparisons difficult and few policies and measures in Japan should be expected to apply directly to Sweden. There should be less of a need for coordination in Sweden, while the need for prioritization should be much greater. Until recently, priorities in terms of specific fields or themes have been treated only on a very general level. While research councils and agencies have been encouraged in general terms to cooperate and coordinate their activities, few specific mechanisms for realizing effective coordination have been established.

The introduction of 24 "Strategic Research Areas" in the most recent research bill from 2008 represented a new development in Swedish research policy. Unlike the Strategic S&T Priorities in the Japanese Third Basic Plan, the Strategic Research Areas are directly linked to allocation of resources. However, the function of the Strategic Research Areas is more specific in that they will serve primarily as a means to direct major new funding to selected universities.

Unlike Japan, there is not yet an overall framework for prioritizing government R&D expenditure in Sweden in terms of scientific, technological or thematic fields. An important basis for developing such a framework would be extensive and systematic international benchmarking of research, innovation and industry in Sweden. Such activities appear more developed in Japan, where there is a wealth of quantitative and qualitative studies from both public and private think-tanks. Considering that Swedish industry is much more dependent on the global market than Japan, the need for global benchmarking is even greater in Sweden.

The role of universities in Sweden as providing the research infrastructure for all sectors of society inherently makes the Swedish research system more integrated than the Japanese one, where most ministries have their own research institutes. On the other hand, this means that universities in Sweden are charged with wider responsibilities than those in Japan.

Appendix 3. Sources for meta-analysis

Title of report	Authors	Year	Sponsor	Available at
A fugitive success – Finland's economic future	Sabel, C., Saxenian, A.	2008	Sitra	http://www.sitra.fi/julkaisut/raportti80.pdf
Evaluation of the Finnish National Innovation System	Veuglers R., Aiginger K., Breznitz D., Edqvist C., Murray G., Ottaviano G., Hyttinen A., Kangasharju A., Ketokivi M., Luukkonen T., Maliranta M., Maula M., Okko P., Rouvinen P., Sotarauta M., Tanayama T., Toivanen O. , Ylä-Anttila P.	2009	The Ministry of Education and the Minstry of Employment and the Economy	https://www.etla.fi/wp-content/uploads/InnoEvalFi_FULL_Report_28-Oct-2009.pdf
Capabilities for Innovation Activities – Impact Study	Wallin J. (ed.), Cooke P., Eriksson A., Laamanen T., Laxell P	2012	Tekes	https://www.tekes.fi/globalassets/julkaisut/capabilities_for_innovation_activities.pdf
Evaluation of Tekes – Final Report	van der Veen G., Arnold E, Boekholt P., Deuten J., Hor-vath A., Stern P., Stroyan J.	2012	Ministry of Employment and the Economy	http://tekes.episerverhosting.com/globalassets/julkaisut/temjul_22_2012_web.pdf
Alueet globaaleissa ekosysteemeisssä – Osaamis-keskusohjelman loppuarviointi	Wallin J., Laxell P.	2013	Ministry of Employment and the Economy	https://tem.fi/documents/1410877/2864661/Alueet+globaaleissa+ekosysteemeiss%C3%A4+04062013.pdf
"License to SHOK?" External Evaluation of the Strategic Centres for Science, Technology and Innovation	Lähteenmäki-Smith K., Halme K., Lemola T., Piirainen K., Viljamaa K. , Haila K., Kotiranta A., Hjelt M., Raivio T., Polt W., Dinges M. Ploder M. Meyer S. Luukkonen T. Georghiou L.	2013	Ministry of Employment and the Economy	https://www.tekes.fi/globalassets/julkaisut/licence_to_shok.pdf
The Impact of Tekes Activities on Wellbeing and Environment	Valovirta V., Lehenkari J., Lehtoranta O., Loikkanen T., Suominen A., Bodewes H, Mostert B, Zegel S., van der Veen G.	2014	Tekes	http://www.tekes.fi/globalassets/julkaisut/wellbeing_and_environment_308_2014.pdf
Innovativeness in Finnish workplaces: renewing working life to bring Finland to bloom	Alasoini T., Lyly-Yrjänäinen M., Ramstad E., Heikkilä A.	2014	Tekes	http://www.tekes.fi/globalassets/julkaisut/innovativeness_in_finnish_workplaces.pdf
Impact of Tekes activities on productivity and renewal	Viljamaa K., Piirainen K., Kotiranta A., Karhunen H., Huovari J.	2014	Tekes	https://www.tekes.fi/globalassets/julkaisut/impact_of_tekes_activities_on_productivity_and_renewal.pdf
Reformative Finland: Research and innovation policy review 2015–2020		2014	Research and Innovation Council	http://www.minedu.fi/export/sites/default/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/julkaisut/liitteet/Review2015_2020.pdf
The impact of Tekes and innovation activities		2015	Tekes	https://www.tekes.fi/globalassets/julkaisut/vaikuttavuusraportti_2015_eng.pdf
The impact of Tekes on capabilities	Halme K., Haila K., Barge B., Dalziel M., Lemola T., Hautamäki A.	2015	Tekes	https://www.tekes.fi/globalassets/julkaisut/impact_of_tekes_on_capabilities.pdf

Title of report	Authors	Year	Sponsor	Available at
Country Report Finland 2016		2016	European Commission	http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_finland_en.pdf
Innovation Ecosystems, Competencies and Leadership. Human Spare Parts and Venture Finance Ecosystems under Scrutiny.	Sotarauta M., Heinonen T., Sorvisto P., Kolehmainen J. (eds.)	2016	Tekes	https://www.tekes.fi/globalassets/julkaisut/329_2016-innovation-ecosystems.pdf
How to Improve Global Competitiveness in Finnish Business and Industry	Reid A., Angelis J., Griniece E., Halme K., Regeczi D., Ravet J., Salminen V.	2016	Tekes	https://www.tekes.fi/globalassets/julkaisut/330_2016_global-competitiveness.pdf
Forerunning innovation support in the field of non-technological innovation – Evaluation of Non-technological Programmes	Oosi O., Gheerawo R., Keinänen J., Parsama L., Pitkänen A., Wennberg M.	2016	Tekes	https://www.tekes.fi/globalassets/julkaisut/2_2016_non_technological_programmes.pdf
TEAM Finland -kasvuohjelmien arviointi	Vesa Salminen, Kimmo Halme, Kristiina Lähde, Valtteri Härmälä, Julia Wiikeri, Helka Lamminkoski, Brian Barge, Margaret Dalziel, Ashley Walker, Mimosa Zhao, Natalie Hughes, Cameron Miller, Katri Haila, Henri Lahtinen	2016	Prime Minister's Office Finland	http://tietokayttoon.fi/documents/10616/2009122/40_Team+Finland+-kasvuohjelmien+arviointi.pdf/44964b00-fdc9-4df6-b26d-20d4b6b58b7c?version=1.0

Appendix 4. Finnish economic development in the 2000s

The Finnish GDP; 2000-2014 (source: statistics Finland, Synocus analysis)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change 2000-2014	2014 share
GDP, EUR million	136 261	144 437	148 289	151 569	158 477	164 387	172 614	186 584	193 711	181 029	187 100	196 869	199 793	203 338	205 268	50,6%	
Value added/GDP, %	87,5%	88,0%	87,7%	87,2%	87,6%	87,4%	87,2%	87,7%	88,0%	87,5%	87,5%	86,6%	86,3%	86,1%	86,1%		
Value added, all industries, EUR million	**119 200**	**127 111**	**130 021**	**132 243**	**138 752**	**143 621**	**150 475**	**163 654**	**170 386**	**158 348**	**163 620**	**170 454**	**172 417**	**175 002**	**176 781**	48,3%	
A Agriculture, forestry and fishing	4 030	3 998	3 968	3 848	3 778	3 752	3 460	4 391	4 198	4 028	4 468	4 649	4 713	5222	5028	24,8%	2,8%
B Mining and quarrying	280	326	346	371	385	381	519	559	661	616	811	810	804	593	615	119,6%	0,3%
C Manufacturing	**32 951**	**34 135**	**33 955**	**33 305**	**34 201**	**34 939**	**37 710**	**41 398**	**40 384**	**30 292**	**31 948**	**32 164**	**29 067**	**29641**	**29408**	-10,8%	16,6%
D Electricity, gas, steam and air conditioning	**1 741**	**2 013**	**2 349**	**2 625**	**2 825**	**2 653**	**3 100**	**3 271**	**3 337**	**3 693**	**4 208**	**3 812**	**3 828**	**4105**	**3971**	128,1%	2,2%
E Water supply; sewerage, waste management and remediation activities	**783**	**815**	**801**	**853**	**889**	**941**	**1 049**	**1 101**	**1 214**	**1 292**	**1 528**	**1 554**	**1 587**	**1644**	**1721**	119,8%	1,0%
F Construction	7 344	7 464	7 254	7 652	8 329	9 256	9 904	11 037	11 817	10 724	10 548	10 905	11 336	11300	11093	51,0%	6,3%
G Wholesale and retail trade	11 034	12 018	12 563	12 735	13 592	14 145	14 098	15 284	16 611	15 151	15 313	16 737	17 436	17222	16992	54,0 %	9,6%
H Transportation and storage	7 356	7 949	7 997	7 949	8 052	8 175	8 059	8 650	8 852	8 183	8 420	8 715	8 947	8873	8913	21,2%	5,0%
I Accommodation and food service activities	1 534	1 831	1 882	1 927	2 152	2 271	2 391	2 568	2 676	2 564	2 661	2 808	2 967	2793	2823	84,0%	1,6%
J Information and communication	5 735	6 858	7 324	7 196	7 811	7 190	7 139	7 931	8 215	8 039	8 168	8 593	8 961	9253	9799	70,9%	5,5%
K Financial and insurance activities	3 791	4 060	3 566	3 354	3 521	3 867	4 260	4 859	4 649	4 563	4 234	4 565	4 635	4332	5243	38,3%	3,0%
L Real estate activities	**11 217**	**11 926**	**12 710**	**13 430**	**14 062**	**14 592**	**15 195**	**15 997**	**17 359**	**17 789**	**18 325**	**19 414**	**20 079**	**20967**	**21807**	94,4%	12,3%
Professional, scientific and technical activities	4 456	4 949	5 023	5 248	5 640	5 947	6 370	7 139	7 645	7 509	7 674	8 316	8 745	8934	8924	100,3%	5,0%
N Administrative and support service activities	2 159	2 418	2 646	2 796	3 122	3 507	3 907	4 432	5 290	5 027	5 273	5 598	5 778	5801	5878	172,3%	3,3%
O Public administration and defence; compulsory social security	7 097	7 427	7 668	8 007	8 346	8 710	9 028	9 420	9 971	10 160	10 292	10 626	10 923	11178	11120	56,7%	6,3%
P Education	5 991	6 335	6 693	6 996	7 328	7 662	7 848	8 204	8 703	9 042	9 409	9 746	10 105	10201	10250	71,1%	5,8%
Q Human health and social work activities	**8 780**	**9 450**	**9 994**	**10 518**	**11 085**	**11 788**	**12 323**	**13 067**	**14 126**	**14 790**	**15 263**	**16 151**	**17 114**	**17460**	**17667**	101,2%	10,0%
R Arts, entertainment and recreation	1 242	1 338	1 406	1 473	1 510	1 583	1 672	1 785	1 987	1 997	2 065	2 219	2 258	2297	2305	85,6%	1,3%
S Other service activities	1 624	1 749	1 819	1 883	2 016	2 140	2 319	2 433	2 542	2 727	2 844	2 897	2 959	2992	3019	85,9%	1,7%
T Activities of households as employers	55	52	57	77	108	122	124	128	149	162	168	175	175	194	205	272,7%	0,1%
Primary production	4 030	3 998	3 968	3 848	3 778	3 752	3 460	4 391	4 198	4 028	4 468	4 649	4 713	5222	5028	24,8%	2,8%
Secondary production	43 099	44 753	44 705	44 806	46 629	48 170	52 282	57 366	57 413	46 617	49 043	49 245	46 622	47283	46808	8,6%	26,5%
Services	72 071	78 360	81 348	83 589	88 345	91 699	94 733	101 897	108 775	107 703	110 109	116 560	121 082	122497	124945	73,4%	70,7%
Services, public sector	21 396	22 563	23 737	24 749	25 765	27 003	27 950	29 227	31 158	32 085	32 871	34 172	35 578	36484	36582	71,0%	
Services, private sector	50 675	55 797	57 611	58 840	62 580	64 696	66 783	72 670	77 617	75 618	77 238	82 388	85 504	86013	88363	74,4%	
D+E+L+Q	**22 521**	**24 204**	**25 854**	**27 426**	**28 861**	**29 974**	**31 667**	**33 436**	**36 036**	**37 564**	**39 324**	**40 931**	**42 608**	**44 176**	**45 166**	100,6%	
D+E+L+Q; percentage share of value added	**18,9%**	**19,0%**	**19,9%**	**20,7%**	**20,8%**	**20,9%**	**21,0%**	**20,4%**	**21,1%**	**23,7%**	**24,0%**	**24,0%**	**24,7%**	**25,2%**	**25,5%**	35,2%	
D+E+L+Q; share of GDP	**16,5%**	**16,8%**	**17,4%**	**18,1%**	**18,2%**	**18,2%**	**18,3%**	**17,9%**	**18,6%**	**20,8%**	**21,0%**	**20,8%**	**21,3%**	**21,7%**	**22,0%**	33,1%	

The Finnish exports; 2002-2015 (source: customs Finland, Synocus analysis)

Exports by product (SITC rev. 4 classification), M EUR														
Product category	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
0 Food and live animals	808	803	816	836	952	1 134	1 171	997	1 141	1 368	1 366	1 378	1 344	1 234
1 Beverages and tobacco	96	73	88	94	112	127	144	137	135	152	160	170	172	163
2 Crude materials, inedible, except fuels	3 127	3 101	3 171	2 999	3 703	3 854	3 241	2 170	3 533	4 059	4 273	4 801	4 548	4 806
3 Mineral fuels, lubricants and related materials	1 607	1 830	2 089	2 287	3 192	3 516	4 489	2 880	4 162	5 481	6 202	6 846	6 028	3 640
4 Animal and vegetable oils, fats and waxes	40	51	58	58	73	33	62	40	50	36	50	25	20	14
5 Chemicals and related products, n.e.s.	3 308	3 331	3 688	4 000	4 569	4 973	5 399	4 593	5 539	6 350	6 350	6 270	6 218	5 930
6 Manufactured goods classified chiefly by material	**14 611**	**14 573**	**16 295**	**15 737**	**19 228**	**20 202**	**18 299**	**12 678**	**16 805**	**18 055**	**16 843**	**16 388**	**16 371**	**16 312**
61 Leather,dressed fur,etc.	59	41	39	37	43	51	36	41	35	36	28	27	23	18
62 Rubber manufactures,n.e.s.	269	288	335	329	399	428	419	273	386	515	525	456	432	432
63 Wood and cork manufactures	921	908	946	957	1 061	1 082	954	579	684	744	725	763	795	799
64 Paper,paperboard and articles thereof	8 574	8 039	8 231	7 266	8 375	8 397	7 814	6 448	7 420	7 600	7 410	7 290	7 099	7 270
65 Textile yarn,fabrics,made up articles,etc.	374	362	333	312	325	353	342	263	258	270	259	248	242	253
66 Non-metallic mineral manufactures,n.e.s.	523	529	564	572	675	681	656	449	483	528	537	539	526	489
67 Iron and steel	2 023	2 594	3 652	3 868	4 679	5 099	4 594	2 319	4 437	4 985	3 996	3 849	3 939	3 900
68 Non-ferrous metals	1 151	1 123	1 476	1 562	2 734	3 050	2 430	1 518	2 301	2 394	2 347	2 051	2 184	2 145
69 Manufactures of metals,n.e.s.	718	689	718	836	936	1 062	1 053	788	800	983	1 015	1 165	1 133	1 007
7 Machinery and transport equipment	**20 596**	**19 585**	**19 499**	**23 106**	**25 826**	**27 796**	**28 729**	**18 211**	**17 118**	**16 654**	**16 612**	**15 080**	**16 075**	**16 703**
71 Power generating machinery and equipment	1 367	1 244	1 412	1 550	1 842	1 952	2 685	2 372	2 172	2 259	2 159	2 199	2 213	2 006
72 Machinery for specialized industries	2 449	2 450	2 682	3 103	3 478	4 382	4 381	2 981	3 543	3 918	4 133	3 775	3 277	3 470
73 Metal working machinery	229	198	206	226	309	345	334	199	215	259	274	286	267	242
74 General industrial machinery n.e.s.	1 863	1 818	2 160	2 510	2 794	3 263	3 730	2 631	2 623	2 871	2 821	2 833	3 072	2 977
75 Office machines and adp machines	329	292	385	518	654	593	474	349	353	373	382	372	370	321
76 Telecommunications and sound recording equipm	8 785	8 209	7 489	9 835	9 646	9 423	9 057	4 294	2 798	2 197	1 636	658	742	650
77 Electric machinery,n.e.s.and parts	2 410	2 429	2 616	2 644	2 820	3 054	3 208	2 398	2 691	2 935	3 015	2 969	3 082	3 054
78 Road vehicles	1 593	1 252	1 530	2 170	2 925	2 875	3 184	1 339	1 160	1 332	1 347	1 288	2 043	2 669
79 Other transport equipment	1 570	1 695	1 021	550	1 358	1 908	1 677	1 649	1 562	511	844	700	1 009	1 314
8 Miscellaneous manufactured articles	**2 690**	**2 649**	**2 756**	**2 919**	**3 046**	**3 259**	**3 337**	**2 716**	**3 003**	**3 225**	**3 399**	**3 518**	**3 787**	**3 544**
81 Prefabr.buildings;sanitary,lighting etc.fixtrs	344	374	395	443	491	551	503	360	383	404	397	385	378	341
82 Furniture and parts thereof	256	258	264	230	224	250	247	133	125	122	114	108	119	116
83 Travel goods,handbags and sim.containers	13	9	12	12	13	22	27	21	23	23	22	22	20	18
84 Articles of apparel and clothing accessories	230	207	224	229	236	253	254	211	249	295	323	337	324	286
85 Footwear	72	68	70	73	81	93	93	81	101	120	120	132	133	98
87 Instruments and apparates n.e.s.	879	910	979	1 064	1 154	1 159	1 270	1 174	1 348	1 421	1 566	1 557	1 773	1 804
88 Photographic equipment,optical goods etc.	49	50	47	44	48	45	39	25	30	36	48	63	74	98
89 Miscellaneous manufactured articles,n.e.s.	848	772	765	823	798	886	902	711	744	804	808	914	966	784
9 Commodities and transactions not classified elsewhere	362	383	456	417	788	796	708	641	953	1 476	1 623	1 519	1 409	1 482
Export of goods total (EUR million):	**47 245**	**46 378**	**48 917**	**52 453**	**61 489**	**65 688**	**65 580**	**45 063**	**52 439**	**56 855**	**56 878**	**55 994**	**55 973**	**53 829**
Comparison to Tilastokeskus statistics:														
(P61K) Export of goods (National accounts)	47 374	46 495	49 063	52 586	61 437	65 745	65 890	45 103	52 478	56 855	57 161	56 312	56 912	55 234
(P62K) Export of services (National accounts)	10 842	9 826	11 633	13 158	13 976	16 638	21 068	19 249	19 639	20 458	20 895	21 265	20 688	22 050
Goods/services export total (National accounts)	58 216	56 321	60 696	65 744	75 413	82 383	86 958	64 352	72 117	77 313	78 056	77 577	77 600	77 284

Appendix 5. Tekes financing in the 2000s

The funding provided by Tekes; 2004-2015 by sector in € (source: Tekes, Synocus analysis)

Industry	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	All years total
A Agriculture, forestry and fishing	66 623	55 901	39 042	95 529	338 468	1 496 103	434 131	231 202	42 595	443 652	306 100	210 466	3 759 812
B Mining and quarrying	945 048	316 001	1 220 231	1 302 386	742 189	606 092	2 584 063	716 447	907 821	414 093	40 911	473 696	10 268 978
C Manufacturing	101 811 869	104 571 643	115 198 920	111 855 834	128 385 578	128 218 308	134 681 799	147 676 008	141 009 311	131 010 823	125 618 838	125 972 070	1 496 011 001
D Electricity, gas, steam and air conditioning	1 435 846	705 141	601 440	755 249	1 043 596	759 568	2 066 668	2 085 346	1 804 585	3 551 863	2 363 166	3 465 882	20 638 351
E Water supply; sewerage, waste management	650 130	592 154	557 811	1 374 322	2 247 972	1 412 723	255 853	1 066 118	1 174 400	873 373	788 542	1 487 989	12 481 387
F Construction	2 011 515	1 882 071	2 153 984	2 634 370	4 386 375	5 282 612	6 366 509	6 313 581	4 408 747	3 463 027	4 143 140	4 637 823	47 683 754
G Wholesale and retail trade	5 889 574	6 047 870	7 937 772	7 525 932	10 530 822	11 070 360	8 741 297	8 734 130	11 613 981	14 590 477	15 217 045	14 690 655	122 589 914
H Transportation and storage	1 697 530	508 772	886 176	1 209 071	1 189 954	1 168 164	684 018	1 733 000	2 037 536	2 532 583	1 767 389	1 791 076	17 205 270
I Accommodation and food service activities	38 020	45 033	34 531	33 642	21 990	293 391	427 694	428 931	212 635	171 351	330 942	387 783	2 425 942
J Information and communication	28 338 284	30 378 956	31 200 515	34 500 205	44 660 075	53 623 747	64 106 374	70 593 239	75 029 752	92 063 632	81 836 219	94 590 241	700 921 239
K Financial and insurance activities	1 662 089	1 805 802	2 685 412	1 945 974	3 134 645	2 362 915	4 643 395	2 931 062	3 047 190	7 403 014	3 861 911	2 816 457	38 299 864
L Real estate activities	746 291	266 678	324 826	609 189	1 524 302	864 094	1 342 878	2 977 356	1 678 575	1 541 959	1 130 531	918 157	13 924 835
M Professional, scientific and technical activities	103 605 735	107 106 962	102 208 933	110 807 807	124 328 456	131 585 827	127 095 627	139 478 455	139 932 834	135 595 888	127 364 762	124 588 038	1 473 699 324
N Administrative and support service activities	849 861	1 140 155	1 426 633	2 033 829	2 112 726	2 538 527	2 835 768	4 557 800	3 080 893	3 286 662	3 406 011	7 105 780	34 374 646
O Public administration and defence; compulsory social security	12 612 329	12 883 178	16 079 316	15 536 951	13 581 214	9 380 473	11 577 933	14 106 764	14 155 991	14 272 518	12 065 345	13 852 299	160 104 310
P Education	75 708 572	79 888 563	81 192 037	77 159 475	80 467 960	97 506 664	137 572 576	155 948 587	139 492 499	128 458 722	114 247 925	101 463 467	1 269 107 047
Q Human health and social work activities	1 583 617	3 011 484	3 245 118	3 423 809	3 979 976	3 017 554	3 533 266	3 781 518	4 244 384	6 460 773	7 321 948	6 747 662	50 351 109
R Arts, entertainment and recreation	33 884	118 708	211 295	398 470	617 924	531 119	789 409	350 174	1 268 277	993 771	1 013 837	473 112	6 799 980
S Other service activities	1 749 753	1 907 764	1 221 542	1 248 699	1 193 074	1 449 428	1 497 327	2 308 507	3 281 391	3 223 689	2 363 372	2 371 144	23 815 691
T Activities of households as employers	0	0	0	0	0	0	0	0	162 785	324 008	3 497	1 407 773	1 898 062
X Industry unknown	1 943 036	-354 358	287 477	230 736	532 850	410 617	1 242 389	1 413 825	1 556 261	1 049 367	1 492 197	1 929 816	11 734 214
Total (EUR)	**343 379 606**	**352 878 478**	**368 713 011**	**374 681 479**	**425 020 146**	**453 578 286**	**512 478 973**	**567 432 048**	**550 142 443**	**551 725 246**	**506 683 627**	**511 381 385**	**5 518 094 728**

The funding provided by Tekes; 2004-2015 by sector, % share (source: Tekes, Synocus analysis)

Industry	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	All years total
A Agriculture, forestry and fishing	0,02 %	0,02 %	0,01 %	0,03 %	0,08 %	0,33 %	0,08 %	0,04 %	0,01 %	0,08 %	0,06 %	0,04 %	0,07 %
B Mining and quarrying	0,28 %	0,09 %	0,33 %	0,35 %	0,17 %	0,13 %	0,50 %	0,13 %	0,17 %	0,08 %	0,01 %	0,09 %	0,19 %
C Manufacturing	29,65 %	29,63 %	31,24 %	29,85 %	30,21 %	28,27 %	26,28 %	26,03 %	25,63 %	23,75 %	24,79 %	24,63 %	27,11 %
D Electricity, gas, steam and air conditioning	0,42 %	0,20 %	0,16 %	0,20 %	0,25 %	0,17 %	0,40 %	0,37 %	0,33 %	0,64 %	0,47 %	0,68 %	0,37 %
E Water supply; sewerage, waste management	0,19 %	0,17 %	0,15 %	0,37 %	0,53 %	0,31 %	0,05 %	0,19 %	0,21 %	0,16 %	0,16 %	0,29 %	0,23 %
F Construction	0,59 %	0,53 %	0,58 %	0,70 %	1,03 %	1,16 %	1,24 %	1,11 %	0,80 %	0,63 %	0,82 %	0,91 %	0,86 %
G Wholesale and retail trade	1,72 %	1,71 %	2,15 %	2,01 %	2,48 %	2,44 %	1,71 %	1,54 %	2,11 %	2,64 %	3,00 %	2,87 %	2,22 %
H Transportation and storage	0,49 %	0,14 %	0,24 %	0,32 %	0,28 %	0,26 %	0,13 %	0,31 %	0,37 %	0,46 %	0,35 %	0,35 %	0,31 %
I Accommodation and food service activities	0,01 %	0,01 %	0,01 %	0,01 %	0,01 %	0,06 %	0,08 %	0,08 %	0,04 %	0,03 %	0,07 %	0,08 %	0,04 %
J Information and communication	8,25 %	8,61 %	8,46 %	9,21 %	10,51 %	11,82 %	12,51 %	12,44 %	13,64 %	16,69 %	16,15 %	18,50 %	12,70 %
K Financial and insurance activities	0,48 %	0,51 %	0,73 %	0,52 %	0,74 %	0,52 %	0,91 %	0,52 %	0,55 %	1,34 %	0,76 %	0,55 %	0,69 %
L Real estate activities	0,22 %	0,08 %	0,09 %	0,16 %	0,36 %	0,19 %	0,26 %	0,52 %	0,31 %	0,28 %	0,22 %	0,18 %	0,25 %
M Professional, scientific and technical activities	30,17 %	30,35 %	27,72 %	29,57 %	29,25 %	29,01 %	24,80 %	24,58 %	25,44 %	24,58 %	25,14 %	24,36 %	26,71 %
N Administrative and support service activities	0,25 %	0,32 %	0,39 %	0,54 %	0,50 %	0,56 %	0,55 %	0,80 %	0,56 %	0,60 %	0,67 %	1,39 %	0,62 %
O Public administration and defence; compulsory social security	3,67 %	3,65 %	4,36 %	4,15 %	3,20 %	2,07 %	2,26 %	2,49 %	2,57 %	2,59 %	2,38 %	2,71 %	2,90 %
P Education	22,05 %	22,64 %	22,02 %	20,59 %	18,93 %	21,50 %	26,84 %	27,48 %	25,36 %	23,28 %	22,55 %	19,84 %	23,00 %
Q Human health and social work activities	0,46 %	0,85 %	0,88 %	0,91 %	0,94 %	0,67 %	0,69 %	0,67 %	0,77 %	1,17 %	1,45 %	1,32 %	0,91 %
R Arts, entertainment and recreation	0,01 %	0,03 %	0,06 %	0,11 %	0,15 %	0,12 %	0,15 %	0,06 %	0,23 %	0,18 %	0,20 %	0,09 %	0,12 %
S Other service activities	0,51 %	0,54 %	0,33 %	0,33 %	0,28 %	0,32 %	0,29 %	0,41 %	0,60 %	0,58 %	0,47 %	0,46 %	0,43 %
T Activities of households as employers	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,00 %	0,03 %	0,06 %	0,00 %	0,28 %	0,03 %
X Industry unknown	0,57 %	-0,10 %	0,08 %	0,06 %	0,13 %	0,09 %	0,24 %	0,25 %	0,28 %	0,19 %	0,29 %	0,38 %	0,21 %
Total (EUR)	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**	**100,00 %**

Tekes's 30 biggest ICT-services customers 2004-2015 (source: Tekes, Synocus analysis)

Organization	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	All years total	Cum. % within ind.	% of Grand
J – Information and communication	**29 772 798**	**32 098 317**	**33 538 277**	**37 193 963**	**49 585 455**	**59 234 463**	**65 655 154**	**73 308 455**	**75 582 611**	**92 862 921**	**82 558 253**	**95 191 095**	**726 581 762**		**13,17 %**
Elektrobit Wireless Communications Oy	810 600	1 099 778	1 813 703	1 453 124	2 699 667	1 710 327	1 049 560	764 824	1 182 347	1 136 898	742 625	1 670 476	16 133 931	2,22 %	0,29 %
DIGILE Oy	0	0	0	0	0	0	0	0	0	9 589 396		165 476	9 754 872	3,56 %	0,18 %
F-Secure Oyj	0	163 399	300 669	16 978	35 330	855 512	669 222	494 679	1 320 032	1 243 935	1 615 084	2 572 486	9 287 326	4,84 %	0,17 %
TeliaSonera Finland Oyj	259 059	627 504	1 405 294	1 880 031	949 880	910 284	959 657	579 600	442 096	178 601	113 003	82 451	8 387 460	6,00 %	0,15 %
Tieto- ja viestintäteollisuuden tutkimus TIVIT Oy	591 717	590 213	468 893	463 027	386 860	2 969 545	422 400	1 879 722	297 315	0			8 069 692	7,11 %	0,15 %
Jolla Oy	0	0	0	0	0	0	0	0	733 848	3 824 000	3 207 600	196 516	7 961 963	8,20 %	0,14 %
Aava Mobile Oy	0	0	0	0	0	775 124	633 329	1 672 559	0	1 794 116	1 223 871	944 439	7 043 439	9,17 %	0,13 %
EXFO Oy	0	0	0	0	0	0	888 609	1 918 695	1 673 111	971 559	730 653	750 021	6 932 647	10,13 %	0,13 %
Medicel Oy	880 000	2 785 812	1 227 689	1 365 000	-2 524	0	0	0	0	0		0	6 255 977	10,99 %	0,11 %
NetHawk Oyj	820 531	533 021	1 186 670	1 069 313	1 018 868	1 266 102	0	0	0	0		0	5 894 505	11,80 %	0,11 %
Multi Touch Oy	0	0	0	0	142 450	235 916	919 909	673 424	582 000	625 800	1 393 859	1 189 076	5 762 435	12,59 %	0,10 %
Codenomicon Oy	142 421	0	205 232	339 014	413 300	530 480	669 942	363 194	275 280	749 466	241 275	998 464	4 928 068	13,27 %	0,09 %
Remedy Entertainment Oy	0	288 006	444 022	379 005	226 505	617 619	289 581	0	278 117	1 466 308	518 268	0	4 507 431	13,89 %	0,08 %
Elektrobit Oyj	0	0	0	716 075	1 235 215	1 926 948	507 698	38 564	0	0		0	4 424 500	14,50 %	0,08 %
Tieto Finland Oy	0	0	63 056	0	436 571	433 434	208 058	612 004	743 233	467 001	368 001	997 901	4 329 259	15,09 %	0,08 %
Ekahau Oy	417 556	472 433	471 309	840 270	637 730	638 331	356 969	376 000	0	0	38 001	41 265	4 289 864	15,68 %	0,08 %
CSC-Tieteen tietotekniikan keskus Oy	182 059	393 399	596 975	562 843	614 440	354 729	251 609	359 759	278 696	127 429	83 304	189 407	3 994 649	16,23 %	0,07 %
ZenRobotics Oy	0	0	0	0	100 000	212 459	713 941	831 594	1 079 576	53 740	677 091	250 000	3 918 400	16,77 %	0,07 %
Napa Oy	189 997	530 398	268 371	151 023	69 796	3 179	114 038	933 834	264 308	381 068	448 435	547 511	3 901 957	17,31 %	0,07 %
Rightware Oy	0	0	0	0	0	149 182	220 818	1 698 270	564 230	264 092	563 608	150 000	3 610 200	17,81 %	0,07 %
Mirasys Oy	103 225	126 833	434 590	398 749	544 459	534 924	567 953	341 709	363 000	0		0	3 415 441	18,28 %	0,06 %
Digia Finland Oy	0	10 435	95 154	198 789	0	115 903	308 579	116 002	506 187	752 569	892 079	401 201	3 396 899	18,75 %	0,06 %
Stonesoft Oyj	0	0	0	0	356 149	752 721	545 414	914 467	711 700	0		0	3 280 452	19,20 %	0,06 %
Ixonos Finland Oy	0	31 675	0	0	0	0	958 664	1 571 935	261 492	317 192		116 770	3 257 728	19,65 %	0,06 %
Verto Analytics Oy	0	0	0	0	0	0	0	0	0	167 500	938 000	1 925 444	3 030 944	20,06 %	0,05 %
Enevo Oy	0	0	0	0	0	0	0	0	220 000	285 000	298 847	2 109 153	2 913 000	20,46 %	0,05 %
Mobisoft Oy	281 740	67 276	313 499	179 556	184 303	69 540	292 560	288 586	272 786	415 864	343 803	162 324	2 871 836	20,86 %	0,05 %
Grand Cru Oy	0	0	0	0	0	0	0	183 000	308 693	946 520	1 154 100	267 676	2 859 989	21,25 %	0,05 %
Capricode Oy	345 107	334 902	152 000	719 692	697 599	140 671	63 163	181 430	45 736	0	100 800	35 976	2 817 076	21,64 %	0,05 %
Mawell Oy	168 625	0	199 524	99 848	138 302	230 519	226 939	523 920	388 807	203 942	443 187	140 061	2 763 673	22,02 %	0,05 %
Other J organizations (1983)	24 580 161	24 043 233	23 891 627	26 361 626	38 700 555	43 801 014	53 816 541	55 990 685	62 790 020	66 900 924	66 422 761	79 287 003	566 586 151	100,00 %	10,27 %

Appendix 6. Strategic Innovation Initiatives; suggestions

Social and healthcare systems

Finland is ranked highly in healthcare among European countries in terms of its value for money performance. Therefore, Finland could provide other countries with valuable knowledge. Sharing this knowledge requires first identifying the existing strengths in the Finnish welfare sector that could provide the basis for Finland to offer comprehensive solutions to other countries looking to improve their social and health care systems.

Recognizing that the Finnish welfare sector is competitive in respect of value for money doesn't mean that there is not still room for improvement, which is also evident in the efforts announced by the present Finnish government. The European comparison indicates that Finland should pay more attention to accessibility, preventive care, and user-friendliness. Thus, the present social and health care reform, the SOTE reform, could also be seen as a major opportunity to strengthen the Finnish innovation environment in the social and health-care sector. The following quotes from the initial interviews support this view:

- The uniqueness of the Finnish healthcare system, and particularly the biobanks, offers a good foundation of an attractive innovation environment in the social and healthcare sector.
- A key success factor will be making the SOTE reform leverage innovation activities by supporting stronger centralization and related, system-level innovations.
- The state can take a stronger role in the innovation activities relating to the health sector. New phenomena, such as biobanks, are offering new opportunities. The innovation policy field cannot be restricted to the Ministry of Employment and the Economy and the Ministry of Education and Culture. We need to broaden our view and recognize the innovation potential of other ministries as well.
- Today a uniqueness factor are the biobanks (isolate population, cohorts, legislation). Public authorities are of high level; it is possible and straightforward to approach and collaborate with them. The Social and Health Care Ministry has developed considerably and they understand the innovation and growth aspects in the health sector.
- We need to ensure that the changes to legislation will not prohibit collaboration between different parties in the healthcare sector.
- There is a need to create a stronger national innovation agenda to establish portfolios of innovations that would combine the interest of developers and funders. This is partially a counter reaction to the extreme independence the universities and hospitals have today regarding ownership of inventions, as brought about by the previous innovation act. The ambition is to develop a joint portfolio/bank between the Helsinki Hospital District, Aalto University, and the University of Helsinki.

The interviews also revealed certain restrictions with the present system:

- The present decentralized structures for commercializing innovations do not meet the requirements of today. Finland has many components: infrastructure, financing, regulations, collaboration. However, these are not structured to serve as a one stop shop for international customers and, thereby, simplify that the process of signing contracts. The bigger challenge is that the components are too fragmented, not aligned around a vision. It is difficult to paint the picture for international investors.
- In bioresearch, we have the same number of centers as in the US (9), which shows there is room for an increased focus. Big clinical research efforts in Finland require up to 70 separate agreements.
- Finland lacks any big corporate players in healthcare. From this point of view, the Finnish healthcare community must create a joint vision before any stakeholder in Finland or internationally will invest.
- In the health sector, collaboration between ministries (Ministries of Employment and Economy, Social & Healthcare, Education) is crucial and doesn't work properly.
- Finland lacks a one-stop shop for those that want to establish innovation activities in Finland in the healthcare sector. Neither HUS nor the universities have a telephone number to call in order to get testbed services.

Based on the comments above, it is evident that when considering the opportunity to strengthen Finland as an innovation environment in social and health care, the main opportunity is in using the SOTE reform as a platform for innovation. This implies that, when considering resource provision, the Finnish government must secure an integrated development agenda with all its agencies, the Ministry of Social and Healthcare, KELA, THL as well as the Team Finland

actors. In addition, there is a need to strongly anchor the development in a citizen-centric view on developing the system which integrates preventive healthcare, social care, and medical care into an overall service system.

As the SOTE legislation represents a significant shift in the market conditions in the Finnish social and healthcare sector. This implies that the major, short-term impact of the Finnish government will relate to market co-creation. Thus, the SOTE-reform should be strongly integrated with the innovation ambitions of Finland. This would unleash considerably more resources for innovation activities, compared to the present departmental approach in which different ministries, THL, KELA, the social and health care districts, university hospitals and universities carry out their own innovation activities with a limited amount of national coordination.

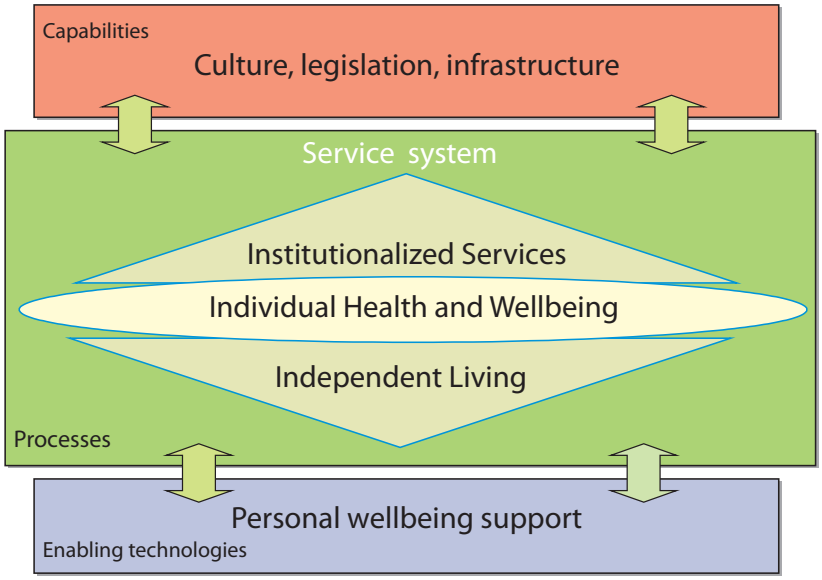
The increased attractiveness of Finland as an innovation environment in this area is illustrated by the fact that global corporations such as GE Healthcare, IBM, and Thermo Fisher have decided to make significant investments in R&D resources in Finland. If and when the SOTE reform and further development of the Finnish social and healthcare sectors leads to increased collaboration between the public and private sectors, with strong involvement of the citizens, Finland has the potential to become a pioneer in embracing new technology to reinvent the social and healthcare system. Here the critical issue is taking a broad view on how citizens can be involved, to not only improve existing processes but enable the use of digitalization and new technologies to further empower citizens and frontline employees in the service organizations in reconfiguring the work to reduce costs and increase customer satisfaction. This calls on the leading social and healthcare districts to take a key role in establishing orchestrated networks that guide the direction of a Strategic Innovation Initiative in the social and health care sector.

Establishing a new way of working within the Finnish social and healthcare sectors to strengthen the attractiveness of the Finnish innovation environment calls for conscious effort on the behalf of the government to secure the continuous strengthening of governmental capabilities. This in turn calls for stronger collaboration across various governmental functions.

If the development activities were properly directed to enable strong public-private-people innovation collaboration, there are clear opportunities that the accumulated learning could provide the basis for exporting the experiences. Such discussions are already going on with countries such as Singapore and China, who are interested in e.g. the results of increased emphasis on home-based care, which has been one of the major reasons for the positive development in Eksote, the South Karelia Social and Health Care District. Eksote emphasizes a new service model based on early, multidisciplinary, intensive, and effective interventions at home, where paramedical care supports other professionals by offering evaluation, medications, and procedures as needed to enable the citizens to avoid leaving their homes. Another stronghold of the Finnish health sector is in health technology, with companies such as Planmeca and GE Health Care having established strong global market positions in their core technologies.

The Strategic Innovation Initiative on social and health care would have to be able to integrate the service and technology aspects to fully leverage upon the possibilities to benefit from the SOTE reform.

Figure 1. A citizen-centric perspective on service systems in social and healthcare.



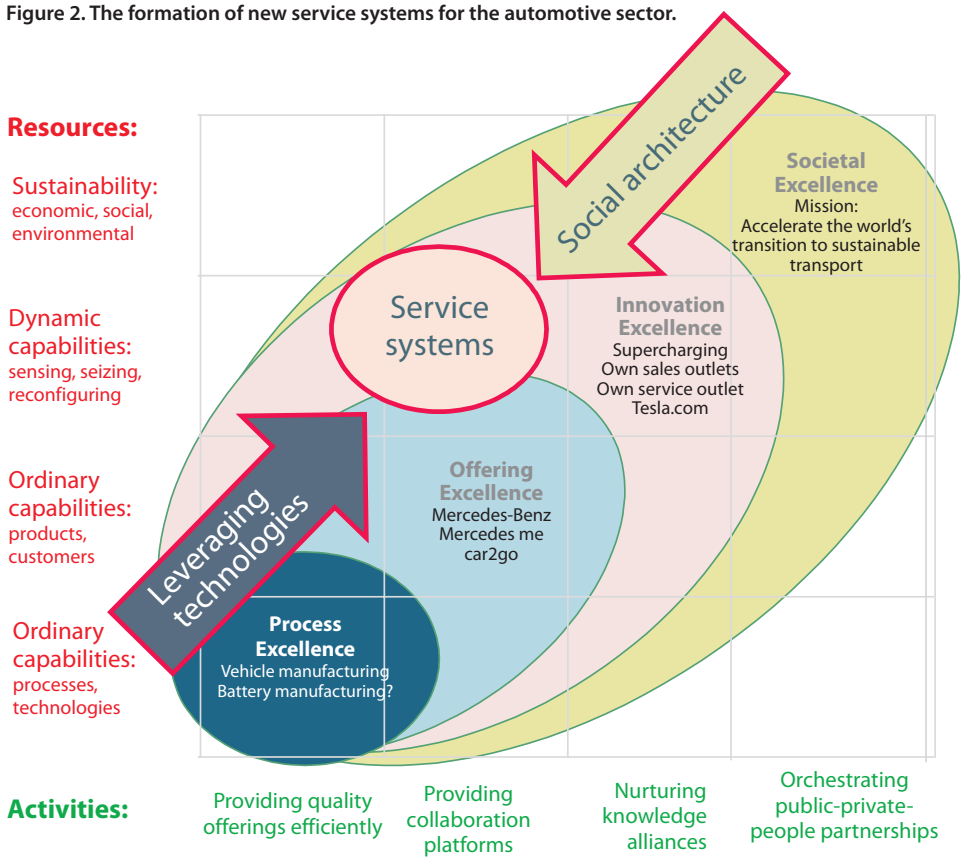
Urban transport

In the initial interviews of the impact study it was observed that the Ministry of Transport and Communications' efforts to reform the transport related regulations ("Liikennekaari") are an encouraging example of the present government's courage in driving some truly new innovative initiatives forward. To bring this effort further it would be important to secure the clear, continued commitment of the public sector in the future as well. This suggests promising opportunities for considering this reform as an innovation platform, which could be used to speed up innovations related to transport.

Based on the experiences from both DARPA in the United States and wind energy in Denmark, we would suggest that the innovation perspective, relating to transport development, should adhere to decentralized experimentation and piloting, operationally under the responsibility of individual cities, whereas the accumulation of knowledge and coordination should be centralized. As the operational responsibility for the recent development of the new regulation has been, to a high extent, handled by Trafi, the Finnish Transport Safety Agency, it would be quite natural for Trafi to take a role in the Finnish transport development similar to that of the Test and Research Centre in Risø in the development of wind energy in Denmark.

The development of urban transport is, to a large extent, driven by the ambition to reduce greenhouse gas emissions and, subsequently, three parallel development trajectories must be constantly monitored and evaluated when guiding the subsequent development: alternatives to fossil fuel for vehicles, autonomous vehicles, and public transport systems. Urban transport will, to a large extent, become the battlefield for the next phase of global digitalization as the car is increasingly perceived as the next major digital platform, extending the possibilities for consumers to be 24/7 digitally available and active. This battlefield will also relate to the logic of the new mobility service systems, where the 100+ year history of the automotive sector, with companies such as Ford, GM, Daimler, BMW, and Toyota, facing the reconfiguration of industry power brought on by the new digital giants such as Apple, Google, and Facebook. In addition, recent startups such as Tesla and Uber also stand a great chance of radically shaking up the automotive sector. How the architecture of the future service system will be influenced by these two drivers is presented in Figure 2. This figure illustrates how an incumbent firm, like Daimler, is trying to develop new services to be better prepared for meeting the new requirements., While newcomers, like Tesla, in turn strongly appeal to issues of societal excellence when pursuing their own strategy.

Figure 2. The formation of new service systems for the automotive sector.



Both Daimler and Tesla are also actively developing self-driving cars, which is also the reason Uber has entered into an industrial partnership with Volvo Cars to collaborate on autonomous car development. The high degree of competitiveness in this market is apparent from Ford's announcement of its intention to develop an autonomous vehicle for ride-sharing fleets by 2021 and GM's partnership with Lyft to develop self-driving cars.

A recent analysis by The Economist of the race to reinvent transport and reshape cities also mentioned the pioneering effort by the city of Helsinki:

> *Ride-sharing services like UberPool, which put travelers heading in the same direction into one vehicle, blur the boundaries between private and public transport. Helsinki and other cities have been experimenting with on-demand bus services and apps that enable customers to plan and book journeys combining trains and buses with walking and private ride-sharing services. Get it right, and public-transport networks will be extended to cover the "last mile" that takes people right to their doorsteps. This will extend the market for ride-hailing well beyond the wealthy urbanites who are its main users today.* (The Economist, September 3rd, 2016)

The Economist continued that it is not clear which companies will dominate this world or how profitable it will be. Much will depend on which firms best handle the regulators.

If the transport regime will be based on a new urban transport infrastructure, it is quite possible that the reconfiguration will be driven by individual city authorities. These will see transport infrastructure as a part, but only a part, of new smart city paradigms, where digitalization and architected platforms will reduce costs, mitigate climate change and, hopefully, also provide better cities to the citizens. Undisputedly the automotive sector will be at the very center of the battle, as the market for personal transport is estimated to amount to as much as $10 trillion a year globally.

Finland could be well positioned to benefit from this trend. In addition to the on-demand bus services (Kutsuplus) piloted by the city of Helsinki, the city of Espoo was a pioneer in piloting the use of electric vehicles in homecare, starting in 2010 in the Eco Urban Living initiative. Following on from this first demonstration program, Espoo has now had electric buses in test use for several years and has, from the beginning of 2016, had the first two Finnish-made Linkker electric buses, owned by HSL, in operation. Other cities with active innovation programs relating to urban transportation are Tampere and Turku. Tampere has put an emphasis on the use of open data to support transport development, and has extended the development to also cover technological solutions to indoor positioning. Turku, in turn, has been a frontrunner in implementing Mobility-as-a-Service solutions for its citizens and has, together with a group of start-up companies, introduced the Tuup app, which enables the booking and payment of bus, train, and taxi services through on an integrated MaaS platform.

The role of the city in providing the physical environment for piloting and demonstrations in urban transportation has been very apparent in the penetration of electric vehicles. Oslo has emerged as the world's leading site for the testing and use of electric cars. Here the national legislation regarding taxation of EVs, combined with the efforts by the city of Oslo, has enabled Norway to become the leading country in respect of EVs. During the first six months of 2016, electric vehicles and hybrids accounted for 24% of the country's total automotive sales-From a national perspective, Finnish development must enable local innovations to compete for support while also engaging in collaboration for a national agenda to unfold. This would enable the development of some unique features of the Finnish urban mobility landscape that would attract not only local start-ups, but also engage large international companies that would strengthen the development efforts. Furthermore, this would also enable solutions developed in Finland to be quickly disseminated and exported to other countries. Another prerequisite for success is the engagement of individual consumers, which has had a critical role both in the success of wind energy development in Denmark and the penetration of electric vehicles in Norway. The need for wise interventions from the government's side could be a way of securing that the development efforts develop complementary capabilities across the cities and the development projects, and at the same time accumulate knowledge and experience to make Finland a frontrunner in urban transport internationally.

Adaptive manufacturing ecosystems

The recent success of the Meyer Turku shipyard indicates that there are certain features of the Finnish mechanical engineering sector which seem to be internationally competitive. Another company which has also been recently increasing its headcount is Valmet Automotive, the contract manufacturer producing A-series and GLC-branded Mercedes Benz cars for Daimler. What is distinctive for these two companies is that they both must adapt to the expectations of a principal located in Germany. Seemingly they have been able to both learn from their principal, but also adapt their learning to the local context in Turku and Uusikaupunki. Meyer Turku has explained its role in the Meyer Group as follows:

> *The strong demand at present for Meyer Turku is based on two important incidents prior to the acquisition of the Turku shipyard by Meyer. Firstly, the evolution of a strong supplier network on the Finnish west coast, which has provided the Turku shipyard with network-level capabilities that can be effectively deployed for demanding customer requirements. Secondly, the support by the Finnish government for the de-*

velopment of new technologies, e.g. considering the first LNG ship, Viking Grace, which became a valuable reference case for the Turku shipyard.

The role of the partner network is also relevant in the case of Valmet Automotive. In the case of Valmet Automotive there are two categories of partnerships that are important. Firstly, when a new car project starts, a considerable investment must be made in the building of the new production line. Valmet Automotive announced in March 2016 that it had signed an agreement with ABB for the delivery of over 250 industrial robots to be installed in the new Mercedes-Benz GLC SUV body shop. Secondly, Valmet Automotive has intimate collaboration with partners supporting the supply chain management and logistics activities related to the car manufacturing. Like Meyer Turku, Valmet Automotive has also been able to very quickly establish a trustful partnership with Daimler.

Both Meyer Turku and Valmet Automotive have also gained international recognition for the competitiveness of their production systems. It would thus be in the best interest of the Finnish manufacturing sector to build upon these experiences to further improve the conditions for the mechanical engineering sector in Finland. Also, important in this case is active interaction with manufacturing experts outside Finland. The success requires the ability to quickly and flexibly integrate a large number of actors into a capability pool for a particular order.

However, if the experiences of Meyer Turku and Valmet Automotive, and similar Finnish manufacturing companies with strong adaptive capabilities, should be leveraged upon for the broader benefit of the Finnish manufacturing sector, it requires a gradual engagement of key actors around what Kramer and Pfitzer (2016) call "collective impact" efforts carried out through the formation of a knowledge alliance (Malmö, 2013). This approach has similar characteristics as the original SHOKs, but the process for establishing the network and the governing principles are quite different. We will use the suggestions by Kramer and Pfitzer (2016) for how to establish an ecosystem of shared value by describing the five elements of "collective impact" in the following.

This process must begin by providing a compelling vision for why the companies should join the collective effort. Setting a shared goal in developing leading knowledge and expertise in adaptive manufacturing ecosystems. To achieve this goal, the network would have to include experts from leading international research institutions as well as the participation of Finnish senior manufacturing expertise. Integrating the physical world of manufacturing with the digital world of simulation, automation, and integration, could be the unifying theme for participation. Handling the complexity that this creates would be addressed case by case in each respective company. Some key notions in the development work could be customization, architecture-based production networks, Monozukuri, connectivity, speed, and the human factor.

In initiating a dialogue with key partners to encourage them to join the Adaptive manufacturing ecosystems Strategic Innovation Initiative would help to specify the benefits that the collaboration could provide. The benefits should be operationalized to form a shared measurement system against which the progress could be evaluated, which is the second key element identified by Kramer and Pfitzer. Benefits of this development could include learning resulting from networking with leading experts, shared research projects with external financing, and company-to-company initiatives that emerge when the collaboration proceeds. Making the benefits clear would also help in forming the common agenda and establishing a basis for understanding what is or isn't working.

In addition to the explicit benefits one could also envisage a number of indirect benefits. By engaging in world-class dialogues with renowned manufacturing experts from all over the world, the participating Finnish mechanical engineering companies could also enhance their employer brands. The interaction between the Finnish companies and the international experts may also open new business opportunities, which may benefit from the collective critical mass of the network, and lead to a stream of mutually reinforcing activities within the network, the third key element when initiating "collective impact".

For the collaboration to become institutionalized it needs to develop various solutions for the exchange of experiences, both virtually as well as through physical interaction, as the complexity of this initiative will not be properly communicable without real-world interaction. This will also make transparent the complementarity of capabilities of the participating organizations. The organizations that join the initiative expect continuous communication on progress. Constant communication is identified as the fourth key element in the formation of an ecosystem of shared value.

The fifth element of a well-functioning ecosystem is dedicated "backbone" support from an orchestrator that can establish trust among the parties and adjust the path forward in synch with how external conditions change and the learning taking place throughout the process. The orchestrator can be a single organization or individual, but it can also be the role of a team that shares the vision and ambitions of the initiative. Agreeing upon the appropriate organizational arrangements for the orchestration efforts is a critical step when establishing the initiative.

Securing the needed capabilities for the initiative to progress as a collective effort would be an important prerequisite to establish a Strategic Innovation Initiative such as the Adaptive manufacturing ecosystems. Here the capability map (Figure 1) is a useful tool when agreeing upon roles and responsibilities within the network.

The here outlined process for the Adaptive manufacturing ecosystems resembles the initial ideas behind the formation of the FIMECC SHOK. In both cases the ambition

would be to stimulate research and collaboration to make Finnish manufacturing more competitive in an increasingly complex business context. However, there are four profound differences.

Firstly, the idea of a Strategic Innovation Initiative is based upon a collective effort, which primarily promotes the sharing of experiences among the participants, of which a significant portion will be from outside Finland. The objective is thus one of **capability building**, which forms the raison d'être for the initiative.

Secondly, the Strategic Innovation Initiative does not aim at becoming an independent economic actor, but is purely **a vehicle for its participants** to achieve their collective goal in a very specific area of competence.

Thirdly, **orchestration is based on collaboration, trust, and authority**. The institutionalization and form of organization should prevent the orchestrator from developing its own agenda in the ecosystem.

Fourthly, the Strategic Innovation Initiative will be strongly **focused on communication**, both internally within the network as well as externally in an open and transparent way, in order to increase the attractiveness of the initiative, and ensure that participants can evaluate the results through their impact outside the network as well. Active communication is also seen as a requirement to achieve the capability building goals.

In supporting a Strategic Innovation Initiative, the government can actively monitor and evaluate its performance and provide exchange of experiences to the Strategic Innovation Initiative from other similar initiatives taking place in different substance areas. The expectation is that, if and when, companies involved in a Strategic Innovation Initiative apply for public R&D and innovation project funding, these applications compete for funding alongside all other projects submitted for funding. However, the assumption is that the Strategic Innovation Initiative will be a filter for not having poor applications submitted on behalf of the participants in the initiative. Submitted applications would also be expected to be well aligned with the expectations of the funding bodies, thanks to the active communication between the initiative and governmental funding agencies.

Waste management and recycling

The interviews conducted for the impact study revealed waste management as a potentially attractive innovation environment. Some of the comments presented were as follows:

- The raw material for waste handling logistics is open data, provided by the authorities, which helps to provide value for the customers. Today e.g. planning algorithms utilize open data on traffic flows during the day.
- The key waste generators and industrial companies that own sites with waste generation today do not have proper control of what quantities and materials of waste are being generated. By gaining an insight through services (and related data) their eyes are opened and this will have a big impact on their behavior. Thus, the waste logistics firms need to change their business model. This can also eventually change the behavior of private households.
- Public sector and different political groups (e.g. trade unions) affect decisions and need to be understood. In Finland, waste incineration facilities are often built in places which lack sufficient raw materials in the interest of providing jobs.
- The government should enforce regulation whereby local waste management decision makers would be forced to buy services from startups over the next 3-5 years. This would support the testing and development of new ideas. Now everything is possible, but not efficiently led.

Finland has several promising startups in the field of waste management and recycling and now a leading national champion as well as Ekokem merged with Fortum. When the transaction was announced the following arguments for the merger were presented:

- Ekokem is a leading Nordic circular economy company that has a strong position especially in treatment of hazardous waste.
- Supported by Fortum's competence in waste-to-energy and financial resources, a true Nordic circular economy champion will be formed. We see excellent growth opportunities for the business.
- With Fortum's network and resources we will be able to expand Ekokem's services more broadly internationally in the future.

The waste handling business of Ekokem will be integrated with the City Solutions business in Fortum, thus providing the opportunity for Fortum to offer a versatile portfolio of different technologies and solutions to city customers.

There are also several ambitious waste to energy demonstrations in Finland, e.g. the world's first eco-gas fueled power plant. Lahti Energy's new Kymijärvi II power plant runs on solid recovered fuel (SRF) that is gasified, cooled, and cleaned before combustion. Another example is in Vaasa where the biggest biomass gasification plant in the world is located. Valmet has been a key technology supplier to both plants.

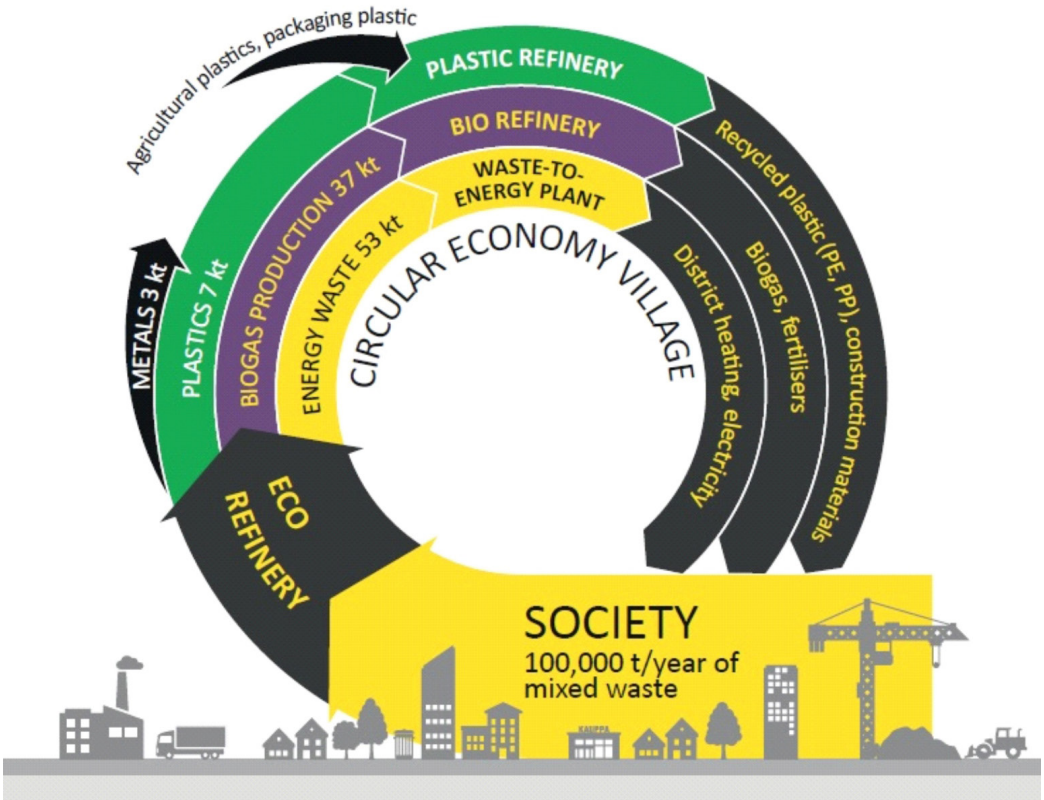
Waste management is an area where the public sector and regulation have an important role in shaping the market. The EU regulation provides the framework for Finland but local adaptations are also possible. In respect of the recycling of household waste the EU goal is to reach 50 % by 2020. The present level in Finland is 34 %, which implies that

there is considerable room for new innovations that could support the increase of waste recycling. To reach this goal, Ekokem has developed what it calls the Circular Economy Village, which is a new type of refinery complex with a recycling rate of about 50% for municipal waste and a utilization rate of 96–98%. The ambition is for this concept to also be exported to other countries. These export ambitions could also benefit complementary small and medium sized companies in the Finnish circular economy sector such as CristolteQ, Enevo, Sybimar, ZenRobotics, etc.

Establishing a Circular Economy Village in a foreign country will call for the same orchestration skills that were described in the section on Adaptive manufacturing ecosystems. In this respect, having Waste management and recycling as a Strategic Innovation Initiative could also benefit Ekokem, as it would have to strengthen its capabilities of orchestrating complex networks with multiple stakeholders and potentially diverging interests. In the case of the Strategic Innovation Initiative, the network of Finnish actors must be mobilized around a vision, which is more than Ekokem's ambition to export its Circular Economy Village concept. Therefore, the participation of the government as a key stakeholder in the "collective impact" efforts would be required. The role of the government can also be one of co-creating markets, by establishing regulations and incentives that would speed up innovation and increase interest in experimentation and demonstrations relating to waste management and recycling. However, most important and valuable is the presence of Ekokem/Fortum, which would secure that when new innovations with international potential emerge, the possibility to leverage upon the network of Fortum would benefit all participants. It can also be assumed that increased collaboration between Ekokem and other actors in the Finnish circular economy sector will provide Ekokem with learning opportunities, and possibilities to include additional technologies and services in the Ekokem solution. The concept of the Circular Economy Village is illustrated in the following Figure 3.

Recently, a project assessing the future of the circular economy in Finland was conducted by the Finnish government to evaluate the potential benefits of a circular economy. It is expected that the circular economy will contribute about €3 billion to the GDP by 2030. At the same time, Finland's greenhouse gas emissions can be cut by several per cent. This, however, requires changes in production, products, services, private and public consumption, and waste management. The current policy measures aim at improved materials efficiency with the focus on wastes, whereas the circular economy calls for new ways of using materials without producing any waste at all. Materials can be prevented from ending up as waste through regular maintenance, repairs, sharing, and by promoting re-use and remanufacturing. A Strategic Innovation Initiative could be one measure to accelerate this development.

Figure 3. The Circular Economy Village by Ekokem.



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