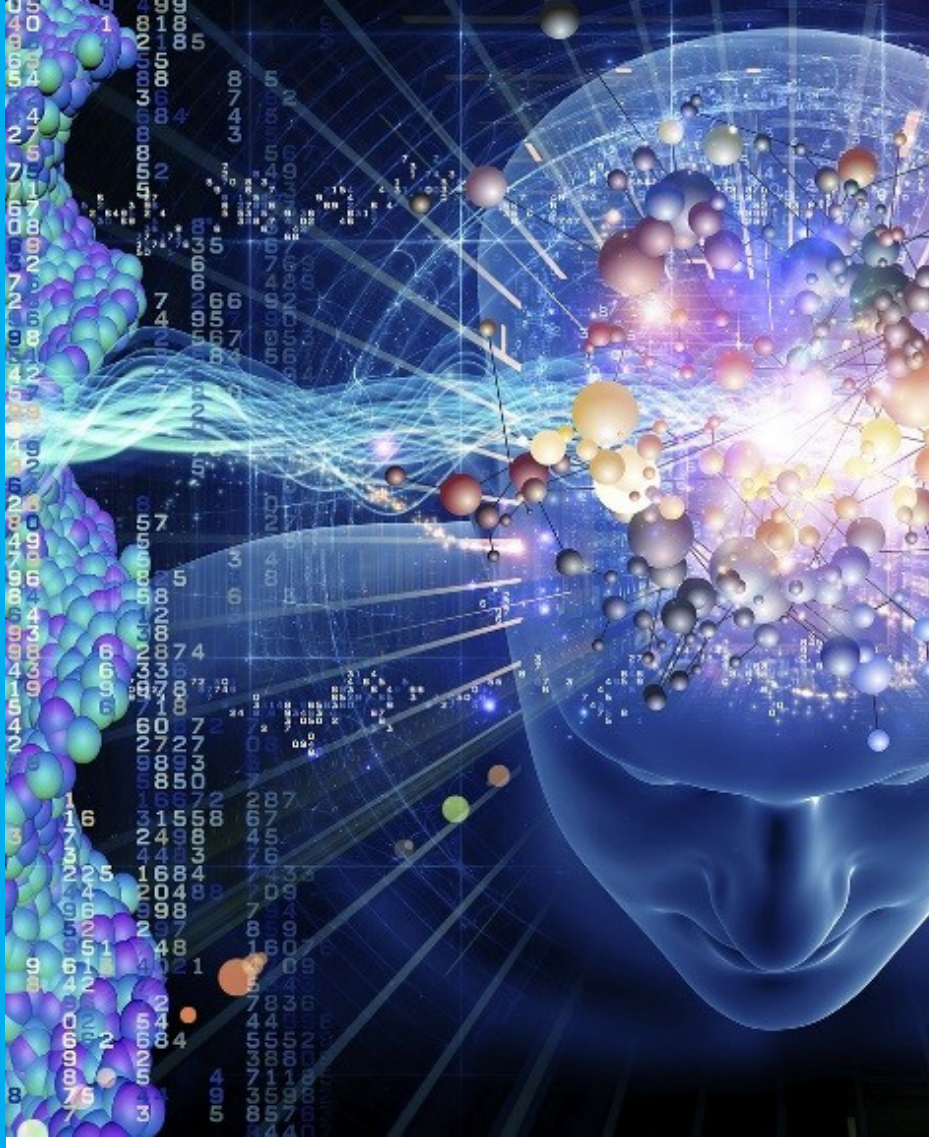

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Executive Summary

The global health and wellness sector is one of the most progressive industries in the world, and the market is being reshaped by the emergence of new technologies and changing societal, patient and consumer demands.

The Finnish health and wellness industry is currently one of the most flourishing national export business areas. The country's health and wellness sector export growth has been very positive for many years. Remarkably, export growth is based on a limited number of companies. This is one of the reasons why there is urgent need to find new growth-oriented companies and new ways to boost future growth of the healthcare sector.

Relevant Finnish companies have been analysed also from the IPR point of view: a clear observation is that all the largest players in the field have a strong and active IPR portfolio as the basis for significant export share of the Finnish health tech industry.

To propose for the potential *Kalewa ecosystem*, thorough investigation is needed to investigate the state of the art of Finnish health and wellness industry. How is the actor network constructed, who and where are the key public and private organizations and stakeholders, service providers, investors, R&D&I-organizations, accelerators, and especially the numerous technology and service companies?

To summarise the analysis, the Finnish health and wellness industry ecosystem is highly complex and dynamic: it is dominated by a rather limited number of large companies responsible for a significant percentage of the total exports in the field. Further, the number of mid-size companies is very low and needs strengthening to support growth. The positive aspect is that the SMEs in the field are numerous and are very dynamically seeking new potential for product and service innovation. Due to the complex operational environment falling under the remit of several ministries, sufficient coordination of the priorities at the national level should be reached to ensure effectiveness and impact of public funding yet allowing the commercial prospects to drive the actual innovation.

The study has been done within the Pre-Kalewa project and is partly funded by Tekes.

1. Finnish Digital Health and Wellness Industry Actors

The health sector in Finland has grown and become more international at a faster pace than many other sectors in recent years. Health technology has turned into a high-tech export sector and a provider of employment of national importance. The value of Finland's exports of health technology products rose to €2.11 billion in 2016, an increase of 9.7% over the prior year. Imports of health technology products rose 8.0% to €1.10 billion. The net trade balance exceeded €1 billion for the first time in 2016 (Figure 1).

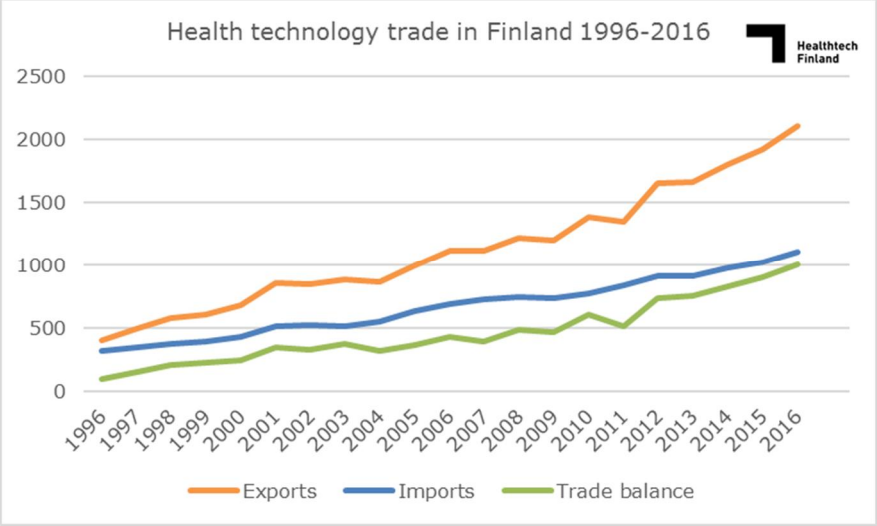


Figure 1: Health technology trade in Finland 1996–2016[1]

A twenty-year analysis, including the years prior to adoption of the euro, shows average growth in the value of health technology exports of 6.2%. Over the last two decades, the value of exports has increased more than five-fold and the net trade surplus has increased ten-fold[1].

[1] Exports of Finnish health technology grew to over €2.1 billion in 2016 – Growth of 9.7% in product exports. Federation of technology industries, Press Release 4.4.2017.

The biggest contributor to the net €1.0 billion trade surplus in 2016 continued to be Finland's traditionally strong medical equipment segment, which contributed nearly 90% of the net total. Exports of medical equipment rose 11.8% to €1,350 million[1].

The second largest contributor was the in vitro diagnostics segment, comprising both diagnostic reagents and equipment. In 2016, exports in the in vitro physiotherapy equipment and products diagnostics segment rose 4.1% overall to €526 million. The segment made a positive contribution of €222 million to Finland's balance of trade in 2016[1].

The growth in exports has not taken place by accident. Long-term investments in education, research, innovation and research infrastructures of this sector lay the foundation of commercial and exports success. There is versatile multidisciplinary expertise, and the quality of the Finnish healthcare system is among the best in the world[2,3].

Healthtech Finland is an industry association and part of Technology Industries of Finland. Healthtech Finland is also a community, fostering our industry's growth and collective knowledge. Healthtech Finland members (nearly 100) cover health technology sector widely including: diagnostics, laboratory solutions, monitoring, imaging, eHealth, artificial intelligence, telemedicine, care, rehab, hygiene, furnishing, logistics and services (Figure 2).

[2] Innovating together. Health Sector Growth Strategy for Research and Innovation Activities. Roadmap for 2016–2018. Ministry of employment and the economy. MEE guidelines and other publications 8/2016.

[3] Terveysteknologia – Healthtech from Finland 2016 -brochure. Fihta.

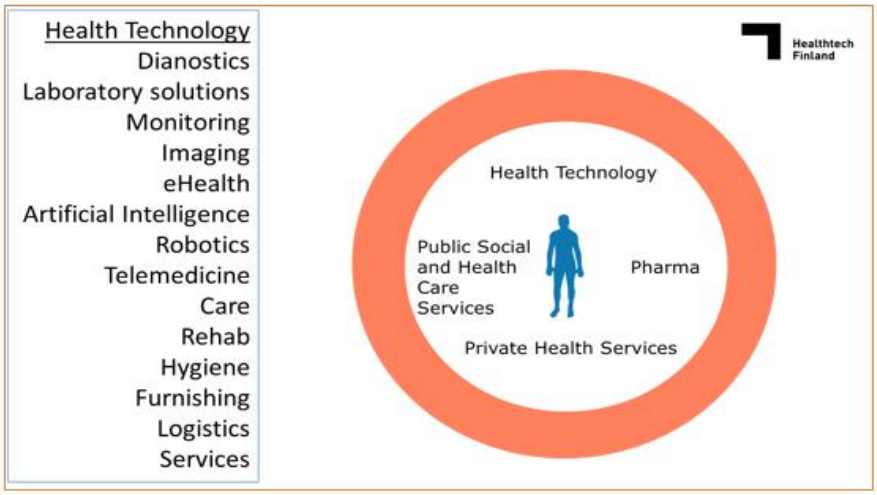


Figure 2: Member sectors of Healthtech Finland[1].

1.1 Goals

This section of the study aims at bringing up-to-date knowledge of the sector boundaries, key private companies, municipal actors and other stakeholder, actor categories and recent development activities. Special interest is to

- Identify key health and wellness ecosystem actors in Finland
  - § Top 10 export companies
  - § Potential growth newcomers
  - § Key municipal players
- Outline ecosystem structure and networking status

1.2 Limitations

There were some limitations of the subject studied. Firstly, co-operation practices between organizations (partnering, networking, clustering, PPP`s, etc.) were not studied, because the availability of this kind of information is limited depending solely on organizations' will-

ingness to share that kind of information on their www-pages. However, some findings based on existence of specific networked roles were included.

Secondly, the aim was not to identify every single focus area company or other organization. There is still a vast number of actors outside this survey. Especially in the technology company categories, there is ongoing change, newly established companies come and go and some of them get new owners. The idea here is to include key players representing the boundaries of the whole ecosystem or selected sub-areas of it, actors having opportunities to boost positively on future development, successful practices and references and findings between neighbouring ecosystems.

Thirdly, areas like hospital and care buildings, hygiene, cleaning, logistics and physical adaptations and aids for in-home care were not studied.

In addition, exact company volume data and complete export statistics of the studied area were not available.

1.3 Methods

The study is based on literature and information gathering from relevant sources. The key information sources were

- Finpro's Health Finland member web-based directory
- Federation of Technology Industry/Health Technology web pages
- Company and organization www pages
- Health and wellness sector reports, publications and scientific articles

1.4 General observations

The Finnish healthcare and wellness ecosystem study revealed a versatile combination of actors, basic competence creators, hundreds of highly innovative companies, diverse infrastructures and comprehensive resources for funding. A promising future is based on existing strong exporters, potential SME`s capable of penetrating the global marketplace and the numerous amount of new start-ups. One observation however can be made that the amount of medium-

sized companies is fairly narrow, which is in line with a very similar situation amongst, for example, the mechanical engineering industry.

Physical product offering of ecosystem members is wide and innovative. Bringing out a few, physical product portfolio includes Beddits sleep tracking solutions, Sartorius AG`s pharmaceutical and laboratory equipment, Optomeds digital imaging instruments, Delfin Technologies wireless skin parameter and edema measurement instruments, Onesys Medical`*s* minimally invasive brain surgery Pen Navigators, HLD`s lymph therapy devices, Valon Lasers high-speed laser scanners, Injeq´s smart needle products *a*nd Bone Index`s hand-held bone index measuring instruments. In these devices, software applications play an important role in the entire solution. Blood glucose meters utilize a cloud platform and intelligent analytics and a bone index measuring instrument without an integrated software solution is useless.

Product companies complement their offerings by life cycle services for customers using their equipment. Physical care device products are supported during their entire customer life cycle by know-how, design, maintenance, cloud-based and consulting services. More closely, HUR for example, offers services for exercising products and Botnia Scan mobile MR-imaging services.

Products enable new service innovations, as in the case of Evondos. Evondos offers a medicine dispensing robot and integrated telecare system, which together enable a medication service concept for elderly people suffering from memory problems and who need long-term medical treatment at home. This customer-oriented and highly personalized service concept can be nominated as a *Medication as a Service concept, or MaaS*. This service improves patients' medical adherence and safety while introducing direct cost savings and quality benefits in healthcare.

An *ICT-based solution offering* is especially versatile covering things such as mobile applications for advancing dental health, healthcare and patient information systems, bioinformatics and genomic data management solutions, smart phone-/medical device-based solutions to prevent stroke and software supported diagnostic imaging systems. *Data-based services* cover such things as Abomics pharmacokinetics interpretation services and Optomed´s information

technology-based workstation, enabling customers to view, analyse and compare retinal images with a graphical interface.

Noteworthy *in healthcare service sector* is the consolidation development amongst private healthcare companies. Acquisitions has been a clear trend for many years, perhaps revealing that the biggest service providers have been actively preparing for health, social services and regional government reform. Attendo, Mehiläinen, Terveystalo Healthcare and Pihlajalinna dominate the markets. Nevertheless, there are still newly established companies – like PerusTerveys Suomi – aiming to grow into a nationwide healthcare service provider and to open up dozens of new units. Also, the occupational healthcare service company, Heltti, aims to develop *preventive digital healthcare systems* based on fixed-fee per cared for customer earning logic, not for on-site visits.

From the *legislation and policy making* point of view, a mix of several ministries, municipal organizations and regulatory bodies may contain certain challenges, since sub-areas of healthcare ecosystems operate under separate ministries. Also, social services and regional government reform is still in the creation pipeline, enabling poorly future giant leap development.

There are also access to *versatile funding assets,* covering national commercially-driven public research funding, private funding options and EU-level funding. Without having any in-depth quantitative monetary perspective regarding funding assets, one may ask traditionally, is there sufficient future funding resources available.

Lists of identified ecosystem players are presented in appendixes 1–8. In the lists there are *short descriptions in italics,* which aim to express every actor's key contribution to the health and wellness area *in business idea level*. In italics, there are also some other interesting observations revealing successful or ongoing projects, partnering issues, strategic aims and recent acquisitions. Ecosystem member presentation in appendixes A-I is based on company and other organizations' www-pages.

The top 10 exporters and 100 fastest growing Finnish companies are presented with the results. They are not included any more in the annexes.

1.5 Top 10 exporters and fastest growing companies

The Healthcare and wellness *export cluster* is the best performing group of export companies offering a wide variety of dental, clinical, treatment, monitoring, tracking and imaging technology devices, related software systems and services. The Federation of Technology Industry-based export statistics present the Top 10 health technology export companies in 2016, which are

- Planmeca
- Kavo Ker Group (previously Palodex Group)
- GE Healthcare (Finnish origin/Instrumentarium)
- Philips
- Thermo Fisher Scientific (Finnish origin/Labsystems)
- PerkinElmer (Finnish origin/Wallac)
- Polar Electro
- Nokia
- IBM
- Microsoft

The top 10 performers can be divided into three categories. The first is original Finnish companies. Another group has roots in Finland, having entered into foreign ownership through acquisitions after establishment. The third group consists of global multinationals having found a new home in Finland for their future R&D&I and businesses.

It is worth noting that previous export statistics do not include exports based on selling software, services and non-regulated medical devices. Hence, companies focusing merely on these product and service areas are not ranked in the top 10 performers list. Furthermore, the abovementioned companies are not presented in order based on export volume, because that kind of information was not available. Anyway, in the long run it has been found that the bigger a company

grows, the bigger share of exports the company can reach (discussion with Federation of Technology Industry/Saara Hassinen 30.4.2017). Finpro has counted that the total number of health, wellness and biotechnology sector export companies is more than 500[4].

Planmeca is a global leader in many fields of *healthcare technology*, with products distributed in over 120 countries worldwide. Their product range covers *digital dental units*, 2D and 3D imaging devices, and CAD/CAM and software solutions. Together with the parent company, Planmeca Group, the group's turnover in 2015 was MEUR 734, employing nearly 2,700 people worldwide.

Kavo Kerr focuses on innovation and quality in *dental products and services*. Kavo offers a comprehensive product portfolio that includes imaging, treatment units, instrumentation, laboratory equipment and educational aids.

GE Healthcare in Finland is a *centre of excellence for anaesthesia and critical care*, employing over 760 health technology professionals, being the 5th largest investor in R&D in Finland among foreign-owned companies. *GE Healthcare's Health Innovation Village* in Helsinki, currently the home of about 30 start-ups operating within health tech and digital health, is an open innovation endeavour, fostering commercialization of health tech innovations and enabling the creation of a health tech ecosystem in Finland. In January 2015, GE Healthcare launched the Mobile Digital Health programme, which aims at combining GE's knowledge of patient monitoring with Finnish expertise in communication technologies to increase the quality of patient care. Originally Finnish Instrumentarium is part of GE.

Philips Medical Systems MR Finland *develops magnetic resonance imaging (MRI) technology-based solutions*. Philips' has in-hospital and home telehealth programmes supporting advanced care delivery models through a combination of technology, clinical expertise and support that enables improved clinical and financial outcomes and better experience of patients. Philips and Salesforce.com have announced a strategic alliance to deliver cloud-based healthcare information technology.

[4] Kauppalehti News 1.6.2017, 13.6.2016 and 8.6.2017.

Thermo Fisher Scientific develops *analytical instruments, lab equipment and specialty diagnostics* providing rapid and accurate results for customers in research, clinical and applied markets. Originally, Finnish Labsystems is a part of Thermo Fisher.

PerkinElmer provides a portfolio of *screening, diagnostic, medical imaging and treatment systems* aiming at a proactive approach to healthcare. Solutions include prenatal risk assessment and neonatal screening, oncology/digital imaging technology and radiation therapy oncology cardiovascular and neurovascular imaging systems. Originally Finnish Wallac is a part of PerkinElmer.

Polar Elektro is a global leader in the field of *wireless heart rate monitoring and training computers*. Polar employs 1,300 people worldwide, has 26 subsidiaries globally and manages a distribution network supplying over 35,000 retail outlets in more than 80 countries. In November 2015, Polar released its first wrist-worn heart rate monitor.

Nokia Technologies – partially thanks to the Withings acquisition – offers *connected health solutions including activity trackers* (Withings Pulse and Activite), Wi-Fi scale and health station (Body Cardio), wireless blood pressure monitor, security camera with air quality sensors (Withings Home) and an advanced sleep system (Withings Aura). Every piece of collected data comes to life in Withings' applications where users can find coaching, motivation and insights to shape key aspects of their health. Nokia Technologies collaborates with care providers such as Helsinki University Hospital to jointly develop new innovative solutions for outpatient care.

IBM has been operating in Finland since 1936, with multiple business divisions that are active in various industry sectors that are strategic for national development, from manufacturing to healthcare. Tekes and IBM have announced a partnership that will enable Finland to utilize Watson cognitive computing to help doctors improve the health of its citizens, and strengthen and develop the Finnish innovation and business ecosystem in the fields of health and well-being. To facilitate the collaboration, IBM intends to establish a *Watson Health Center of Excellence* in Finland, the first Nordic *Healthcare Competence Center*, and the first National Imaging Center of Excellence outside the United States in Finland. These centres are expected to employ 150 people over the next few years.

Microsoft offers wide variety of *digital health services*, covering virtual health, medical data storage, clinical analysis, operational analysis and cybersecurity in health.

In addition, Kauppalehti published recently a listing of the 100 fastest growing Finnish companies in 2016. This list includes five healthcare companies: Reagena, Hippo Terapiaklinilkka, Blueprint Genetics, Suomen Hoivatilat and Eloni[4].

Reagena is a chemistry company *providing infectious disease diagnostics and liquid-based solutions and reagents for life sciences*. The solutions are used in clinical laboratories, diagnostics industry, biotechnology, pharmaceutical industries, environmental and food industries, universities and research institutes.

Hippo Terapiaklinikka offers *personalized therapy and medical services* for children, young people and adults.

Blueprint Genetics is a *genetic knowledge company* that provides comprehensive *genetic testing services.*

Suomen Hoivatilat *specializes in producing, developing, owning and leasing day-care centres, nursing homes and service blocks*.

Eloni is a *medical service company*. Eloni was acquired in 2016 by Diacor. Diacor and Terveystalo merged in 2017.

Kauppalehti published more recently a snapshot of the Finnish Super Growth companies whose net sales have grown roughly from 10 M€ to 100M€ in the 2000s. This list includes 49 Super Growth companies and Top 10 Challengers. The growth list includes six healthcare companies: Pihlajalinna, Esperi Care, Terveystalo Healthcare, Attendo, MI-Hoiva and Cor-Group, meanwhile Mainio Care is ranked on the Challengers list[4].

1.6 Outlining the ecosystem structure

The Health and wellness industry ecosystem consists roughly of public and private organizations (Figure 3). The total amount of players is perhaps calculated in thousands.

Figure 3: Health and wellness ecosystem main division into public and private organizations.

Finpro offers a closer perspective to the ecosystem composition. As a part of this, Finpro hosts the Team Finland growth programme *Finland Health portal*, which enables information of Finnish healthcare private companies and other sector stakeholders (Figure 4). The free-of-charge portal is aimed to support growth-oriented healthcare start-ups. It enables also global funding organizations to scan potential Finnish target companies. In addition, the portal provides up-to-date information about sector renewals, innovations and upcoming interesting events.

At the moment (5/2017), Finpro's portal provides snapshots of 231 companies and 45 institutions. Companies joining the portal may choose themes – describing "focus areas" – and tags describing "key offerings" (Picture 4). The number of chosen themes and tags highlight the most important areas, as well as the extremes. Although there are plenty of actors outside the portal, Finpro's tool provides a useful tool also for ecosystem studies.

Figure 4: Finland Health portal actor themes/"focus area" (upper picture), tags/"offerings" (lower picture) and actor quantity[5].

Ecosystem is a powerful metaphor thanks to symbiotic co-evolution and self-organizing characteristics borrowed from biological ecosystems and applied to business ecosystems. At the core of the ecosystem there is joint innovation and value co-creation, collaboration and also competition. In flourishing ecosystems, highly specialized actors join information, core competences and resources. Value created together is more than the sum of operating alone. Every ecosystem has its unique structure, actors, change status, governance, roles, core and its unique boundaries, which are illustrated in Figure 5.

[5] http://www.finlandhealth.fi/

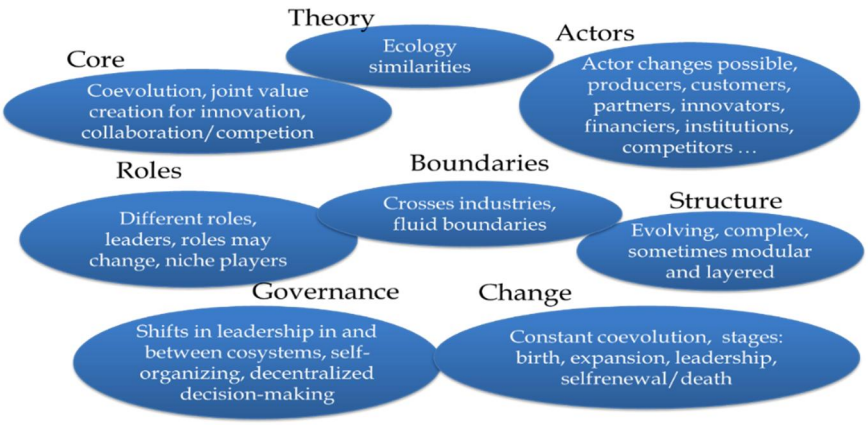


Figure 5: Ecosystem boundaries[6,7,8,9,10].

There are obviously dozens of ways to picture ecosystems. One traditional way is to divide the ecosystem and its actors to

- Base competence creators (education, universities, research institutions…)
- Funding for R&D&I (Tekes, Sitra, Academy of Finland, private funding…)
- Infrastructures and networks (University hospitals, healthcare operating units, R&D actors, Salwe, accelerators…)

[6] Irene Lehto, Jan Hermes, Petri Ahokangas, Jenni Myllykoski; Collaboration in cloud businesses – Value networks and ecosystems. Department of Management and International Business, Oulu Business School, University of Oulu, Finland.

[7] Iansiti, M. & Levien, R. (2004). The Keystone Advantage. What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability. Massachusetts: Harvard Business School Press Boston.

[8] Moore, J. F. (1993). Predators and prey: A new ecology of competition. Harvard Business Review, May-June 1993, 75–86.

[9] Moore, J. F. (1998). The rise of a new corporate form. The Washington Quarterly, Winter 1998, 167–181.

[10] Moore, J. F. (2006). Business ecosystems and the view from the firm. The Antitrust Bulletin, 51(1), 31–75.

- Legislation and policy makers (STM, TEM, OKM, Fimea, Valvira…)
- Markets and demand (patients, citizens, public and private healthcare operators, hospitals, technology providers, importers…)

The Finnish and healthcare and wellness ecosystem includes a wide variety and amount of actors, private companies and public organizations (Figure 6). This “mother” ecosystem is characterized by a fragmented structure, high complexity, active change, interdependence, co-operation, competition and coevolution. Its recent expansion is mainly due to extremely multifaceted activities amongst start-up companies. Secondly, global multinationals boost ecosystem boundaries and accelerate innovations and growth. Ecosystem boundaries cross industries and neighbouring ecosystems. Like any other ecosystems, this ecosystem is unique and extraordinary and it will be never perfect. An example of an ongoing trend where information technology-based ecosystems “conquer” neighbouring ecosystems is Apple’s Finnish sleep tracking solution company, Beddit, acquired in May 2017. Beddit was established in 2007, making sleep quality measuring solutions. This acquisition reveals that our start-ups hold assets that tempt global multinational players, in this case consumer electronics and software. Partly, this case may also reflect the needed time span that it takes for a start-up company to reach global markets.

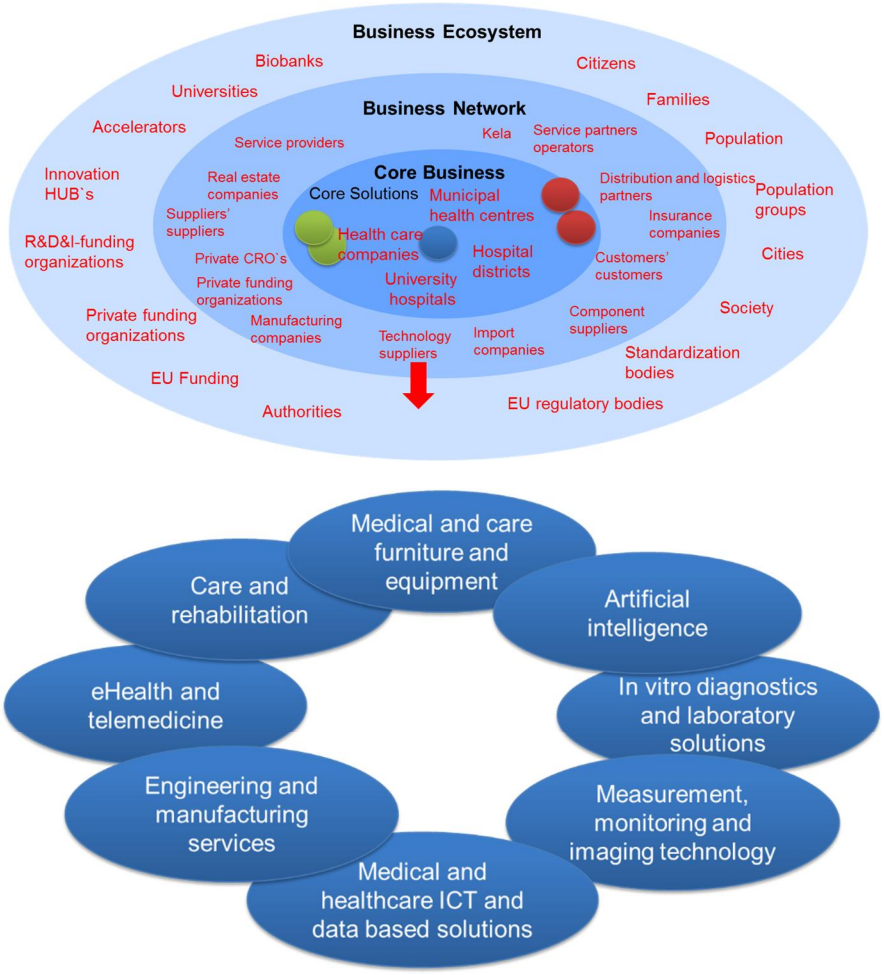


Figure 6: Finland healthcare and wellness ecosystem composition.

A closer look at the *healthcare and wellness technology cluster* reveals eight vital sub-areas: medical and care furniture and equipment, eHealth and telemedicine, care and rehabilitation, in vitro diagnostics and laboratory solutions, measurement, monitoring and imaging technology, medical and healthcare ICT and data-based solutions, engineering and manufacturing services, medical and care furniture and equipment and artificial intelligence. Technology-based cluster companies number in the several hundreds; a vast majority of them are SMEs (Figure 7).

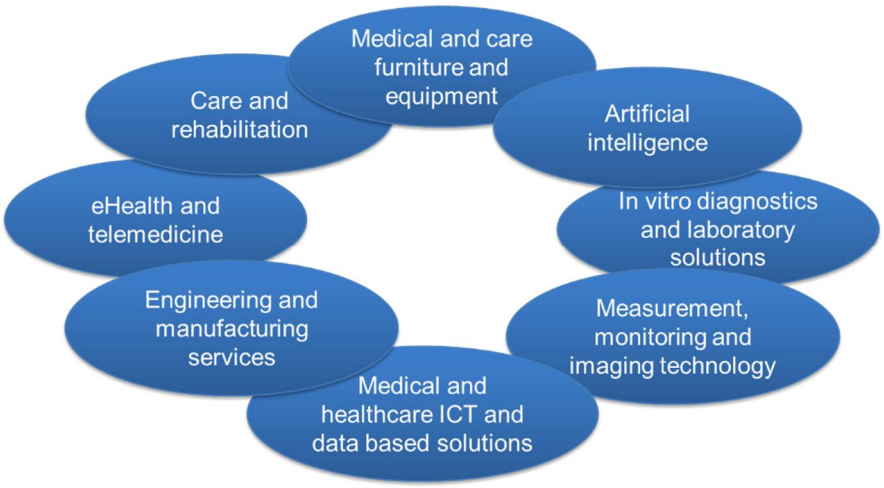


Figure 7: Finland healthcare and wellness technology sub-areas.

1.7 Networking

The followed investigation approach enabled some networking-based observations, though companies do not usually share information about their closest partners or even suppliers. Nevertheless, findings based on *specific networking roles* amongst ecosystem members reveals that there are conscious networked goals, relational partnerships and value chains active in multiple processes.

An example of a specialized material supplier is Hytest. Hytest serves IVD-technology companies by manufacturing monoclonal antibodies and antigens that are mainly used as key components of laboratory tests. Hytest products can be used in several clinical areas including cardiac markers, infectious diseases, metabolic syndrome and veterinary diagnostics. So, Hytest is a key raw material suppliers for the entire Finnish IVD industry.

Considering device and equipment manufacturing services, there are several manufacturing-based service companies in good positions to provide manufacturing services, whether there is need for components or precision mechanics, manufacturing automation or even additive manufacturing services.

Amongst public social care services (Kotitori) and private care services (Luona) networked *service integrators* operate between municipal organizations, service providers (typically micro companies), customers and their relatives.

One example of an *export-oriented network* is the so-called *diabetes network,* which includes seven Finnish companies, which are Evondos, Evalua, Extensive Life, Oivauni, Optomed, Mendor and Sensotrend. There is no evidence that this network is still active.

There are also several partnering examples, which are

- Biisafe (wearable safety devices and related software) *w*orks together with the jewelry brand, Kalevala Koru
- Pohjola Hospital cooperates with most insurance companies
- Tekes and IBM have announced a partnership that will enable Finland to utilize Watson cognitive computing
- Aalto offers a health platform to deepen and widen their work with partners
- UPM Biochemicals and The Institute for Molecular Medicine Finland (FIMM) have started a joint research project with the purpose of investigating the applicability of UPM's new cellulose-based gel material for cancer research.

1.8 Emerging growth opportunities

The top 10 exporters list in Section 1.5 will presumably align global business opportunities in the sector in the near future, since the growth trend has been constant for many years. The most successful export areas are at the moment medical equipment and in vitro diagnostics. Strong export capability is based on determined growth orientation, pertinent capability development, acquisition-based resources and market opportunities. However, highly positive export growth depends on a limited number of bigger companies. The urgent question is to boost new companies and especially SME`s to find their growth pathways. Finpros Finland Health portal is one prospective tool to enhance this development. Beddit and Evondos cases show that global market penetration takes approximately 10 years. There is a lot of work to do in nurturing new potential growth companies.

The R&D&I cluster is a versatile combination of universities, public and private organizations, start-up accelerators and service providers for NPD-customers. Service offering examples cover R&D, product requirements management, expertise, training and information services, pharmaceutical, biotechnology, functional food and device sector CRO-services, productization services, product registration services, CE-markings, sales approvals, analytical services, drug studies, medical device investigations, robot-assisted testing services and inspection, verification and testing services. There are also multiple variations and amounts of well-established accelerator organizations, testbeds and Living Labs. Examples are GE Innovation Village, Vertical, OYS TestLab, Eptek, Vigo and Mariachi Kasvattamo programmes for start-ups and inventors. As an example, the Vigo programme was established in 2007 by MEE. Vigo alone has accelerated within 10 years to over 150 companies, tens of exits and over 400 million euros worth of funding. The Vigo operation model was handed over to Finac in 2016. Also, the Watson Health Center of Excellence and numerous bio banking testbeds enable scientific discoveries and innovative business solutions.

One trend accelerating new growth opportunities is multinational companies' interests to make use of our knowledge base and locate their R&D&I and businesses in Finland. This is evidence that we have competencies and favourable development infrastructures. Besides healthcare multinationals, there are also huge information technology players willing to locate their R&D activities in Finland. This trend will possibly continue boosting new possibilities for Finnish technology and service providers and start-ups.

Novel material technologies may provide sources of new innovations for healthcare products and vital boosts to businesses. There are already some innovative references. *Bioretec* focuses on bio-absorbable, bioactive and drug-releasing surgical implants. *Onbone* makes splints from wood chips and biodegradable plastic which can be moulded without water or gloves. *Lunette* develops medical silicon-based, re-usable menstrual cups. Originally a plastics company *Serres* has specialized in surgery suction bag systems, suction ejectors and suction bag emptying systems. *Bioxid* develops new biomaterials used in dentistry, orthopaedics, and different clinical areas. Lately, *UPM Biochemicals* has launched a wood-based cellulose nanofibril hydrogel for 3D cell culturing and other biomedical applications. GrowDex® is highly biocompatible with human cells. UPM

aims to develop nanocellulose-based wound care applications. UPM Biochemicals and The Institute for Molecular Medicine Finland (FIMM) have started a joint research project with the purpose of investigating the applicability of UPM's new cellulose-based gel material for cancer research.

The health and wellness ecosystem is under constant change and a snapshot of its current status is outlined in Figure 8. Shifts in leadership between ecosystems happen and ecosystem boundaries are extremely flexible. Digitalization and related technology advancements – such as IoT, VR, AR, AM – are opening up new possibilities for healthcare companies to enable new products, customer-oriented services and reduced costs. As an example, additive manufacturing (AM) could be one possible technology to be used in micromechanics-based medical solutions, three-dimensional miniaturized objects, features and internal structures that cannot be processed by using traditional manufacturing methods. AM has already been demonstrated in making human organs, it can be used for making spare parts for medical devices and it is capable for making also personalized medicines.

Figure 8: Snapshot of healthcare and wellness ecosystem change status and examples of emerging technologies (AM=Additive Manufacturing, VR=Virtual Reality, AR=Augmented Reality, IoT=Internet of Things).

2. Finnish Digital Health and Wellness IPR portfolio

This section analyses and describes the IPR landscape of the Finnish Digital Health and Wellness sector.

The analysis describes the results of an analysis of 1722 documents found from Derwent World Patents Index database using company names, words and phrases and international patent classification. The aim of the analysis was to get an overall view of the Finnish Digital Health and Wellness sector. The study was done for the Pre Kalewa project and is the deliverable of Task 1, as described in the final version of the project plan.

2.1 Limitations

Due to the wide extent of the thematic area of health and wellness, this analysis does not attempt to give an exact and comprehensive description of all the IPR based on patents in this field. This topic is difficult to define because it crosses many disciplines and the classification information available varies between the data sources. However, it describes the trends and topics at the top level to document what is happening in the patent area by the Finnish actors.

2.2 Methods

This section describes the results of an analysis of 1722 documents. The aim of the analysis was to get an overall view of the Finnish Digital Health and Wellness sector. The study includes patent documents from over 50 patent offices.

Patent families (separate inventions) of the Finnish health/wellness sector were retrieved from the value-added Derwent Word Patents Index database and analysed and visualized with the STN AnaVist text and data mining tool. In this study 1722 documents were analysed and visualized. STN AnaVist gathers similar documents into clusters and creates a map showing the results of clustering. It also offers a variety of other ways for analysis and visualization, e.g. technology sectors, main players, and geographic distributions also in relation with each other. Methods and tools are described in detail in Appendix J.

The search gave 1722 patent families; there were no yearly restrictions done. There are 126 organizations that have two or more patent families in this search and about 200 that have only one patent family or one application only.

2.3 Overview

First, the tilted view of the map (Figure 9) is presented. Similar documents are gathered into clusters. The similarity is decided based on how many similar terms are used in the documents. The two words next to each cluster show the two most frequent words in the documents. The closer two clusters or documents are, the more similar their contents. Colours indicate the size of the cluster: the more red there is, the bigger the cluster is (and the more documents are included in the cluster).

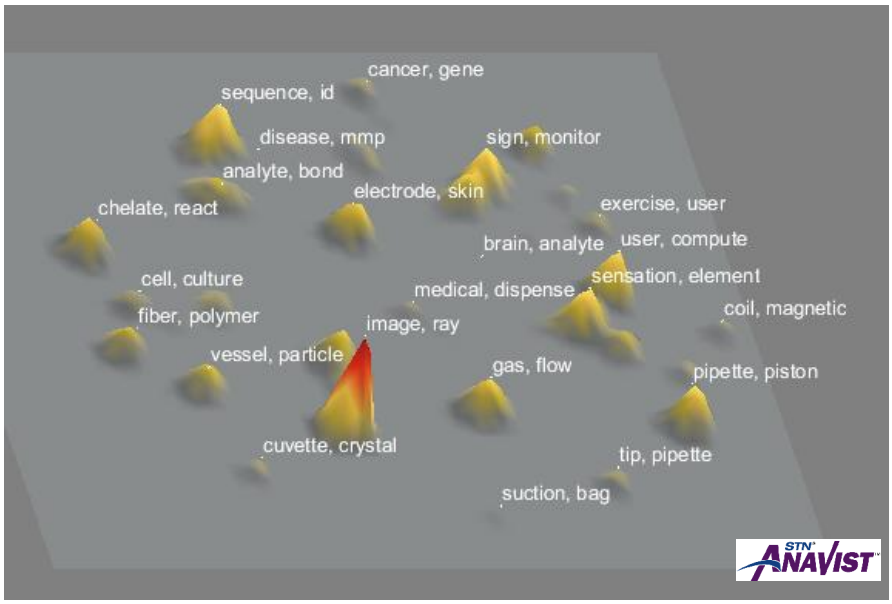


Figure 9: Topographic map of patent documents of Finnish health/wellness companies in tilted form. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents Index database.

In Figure 10 there are key organizations, patent countries, international patent classifications and priority year trends of documents found in this search for the Finnish health/wellness sector.

These are shown and analysed more in the forthcoming chapters.

It seems that patenting has been quite active already for some time. There was a little decline during the last financial crisis, but patenting had recovered and has grown a lot since 2009.

There are many companies in this sector in Finland. In this patent search there are more than 300 companies. Only six of them has more than 100 patent families and three more that have over 50 patent families. An additional 7 have over 20 families. Additionally, 7 have 10–20 patent families and 24 with 5–10 families.

So less than 50 of these companies have over five patent families. About 200 organizations have only one patent family or only one patent application. That means that there are lot of small companies (start-ups) that are active in the Finnish health/wellness sector.

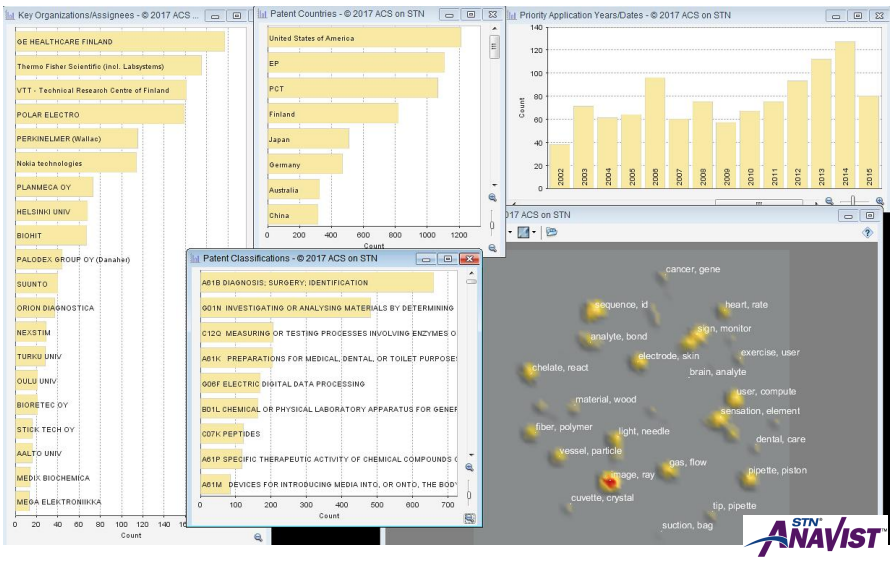


Figure 10: Key organizations, patent countries, international patent classification and priority year trends of documents on Finnish health/wellness companies. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.

There are some big global companies that operate also in Finland: GE Healthcare, Thermo Fisher Scientific and PerkinElmer.

2.4 Key players

Here are the key patenting organizations found in this search (Figure 11 & Figure 12).

Figure 11: The most active patenting organizations in this search. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.

Figure 12: The remaining organizations that have more than one patent family. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.

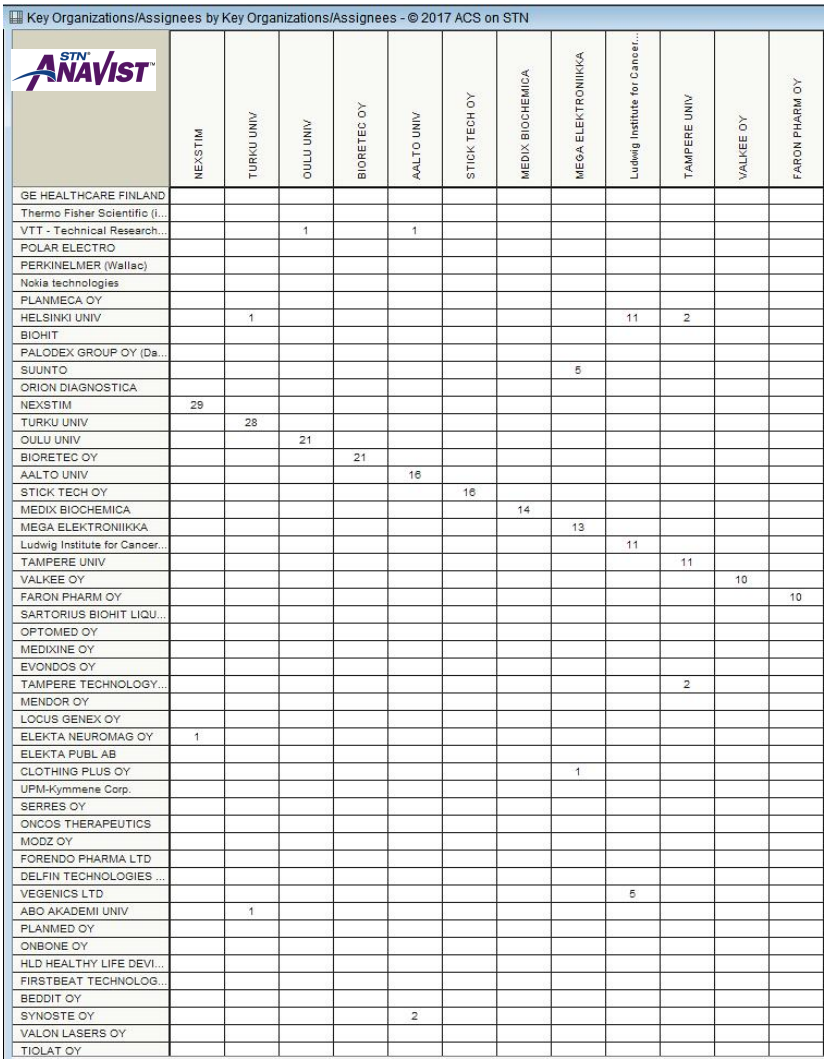
2.5 Cooperation

Here are the cooperation patents between organizations in this search (Figure 13 – Figure 16). For example, Orion has cooperated with GE Healthcare, PerkinElmer and Palodex.

Key Organizations/Assignees by Key Organizations/Assignees - © 2017 ACS on STN

	GE HEALTHCARE FINLAND	Thermo Fisher Scientific (i...	VTT - Technical Research...	POLAR ELECTRO	PERKINELMER (Wallac)	Nokia technologies	PLANMECA OY	HELSINKI UNIV	BIOHIT	PALODEX GROUP OY (Da...	SUUNTO	ORION DIAGNOSTICA
GE HEALTHCARE FINLAND	197									14		2
Thermo Fisher Scientific (i...		175										
VTT - Technical Research...			161									
POLAR ELECTRO				159								
PERKINELMER (Wallac)					115							2
Nokia technologies						114						
PLANMECA OY							73					
HELSINKI UNIV								68				
BIOHIT									67			
PALODEX GROUP OY (Da...	14									44		1
SUUNTO											40	
ORION DIAGNOSTICA	2				2					1		37
NEXSTIM												
TURKU UNIV								1				
OULU UNIV			1									
BIORETEC OY												
AALTO UNIV			1									
STICK TECH OY												
MEDIX BIOCHEMICA												
MEGA ELEKTRONIIKKA											5	
Ludwig Institute for Cancer...								11				
TAMPERE UNIV								2				
VALKEE OY												
FARON PHARM OY												
SARTORIUS BIOHIT LIQU...									4			
OPTOMED OY												
MEDIXINE OY												
EVONDOS OY												
TAMPERE TECHNOLOGY...			1					1				
MENDOR OY												
LOCUS GENEX OY									6			
ELEKTA NEUROMAG OY												
ELEKTA PUBL AB												
CLOTHING PLUS OY											1	
UPM-Kymmene Corp.												
SERRES OY												
ONCOS THERAPEUTICS												
MODZ OY												
FORENDO PHARMA LTD												
DELFIN TECHNOLOGIES ...												
VEGENICS LTD								5				
ABO AKADEMI UNIV			1					2				
PLANMED OY							1					
ONBONE OY												
HLD HEALTHY LIFE DEVI...												
FIRSTBEAT TECHNOLOG...												
BEDDIT OY												
SYNOSTE OY												
VALON LASERS OY												
TIOLAT OY												

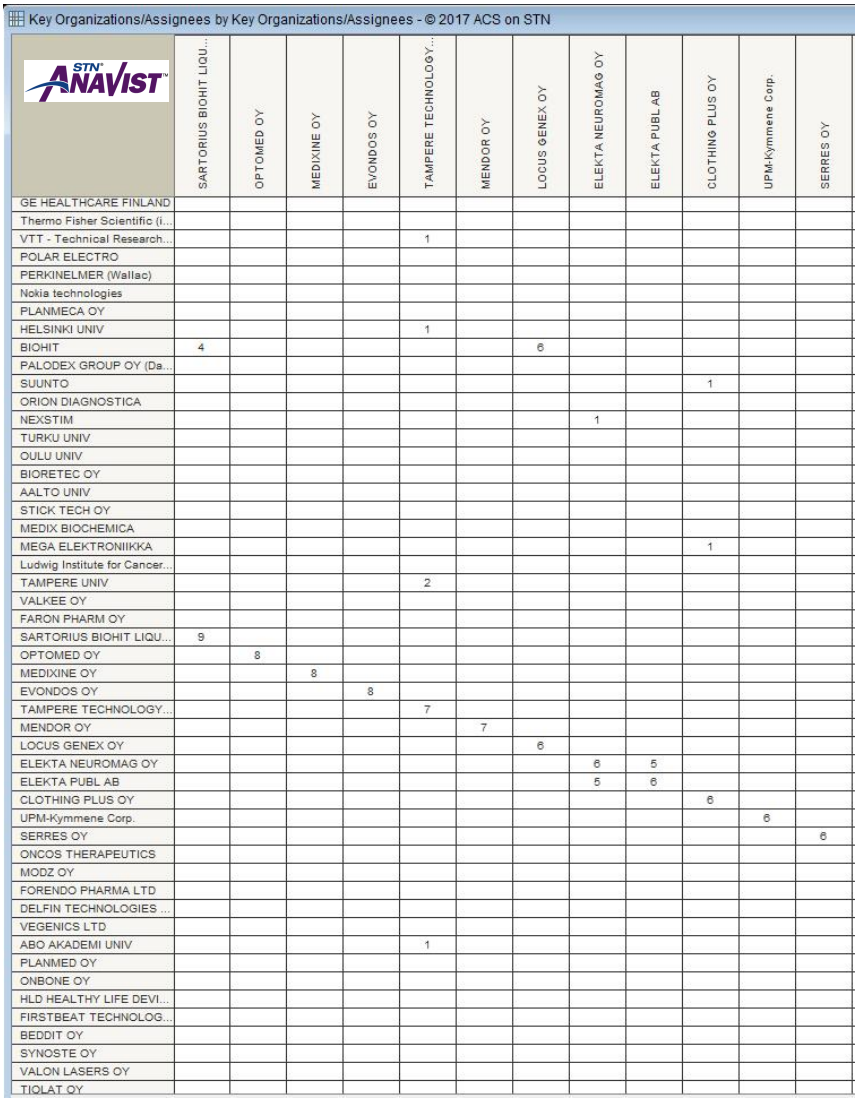
Figure 13: Here the cooperation between companies can be seen. As would be expected, Helsinki University has cooperated with many organizations like Turku Univ., Ludwig Institute for Cancer, Tampere Univ. and Tampere Technical Univ., Vegenics and Åbo Akademie. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.



Key Organizations/Assignees by Key Organizations/Assignees - © 2017 ACS on STN

	NEXSTIM	TURKU UNIV	OULU UNIV	BIORETEC OY	AALTO UNIV	STICK TECH OY	MEDIX BIOCHEMICA	MEGA ELEKTRONIIKKA	Ludwig Institute for Cancer...	TAMPERE UNIV	VALKEE OY	FARON PHARM OY
GE HEALTHCARE FINLAND												
Thermo Fisher Scientific (i...												
VTT - Technical Research...			1		1							
POLAR ELECTRO												
PERKINELMER (Wallac)												
Nokia technologies												
PLANMECA OY												
HELSINKI UNIV		1							11	2		
BIOHIT												
PALODEX GROUP OY (Da...												
SUUNTO								5				
ORION DIAGNOSTICA												
NEXSTIM	29											
TURKU UNIV		28										
OULU UNIV			21									
BIORETEC OY				21								
AALTO UNIV					16							
STICK TECH OY						16						
MEDIX BIOCHEMICA							14					
MEGA ELEKTRONIIKKA								13				
Ludwig Institute for Cancer...									11			
TAMPERE UNIV										11		
VALKEE OY											10	
FARON PHARM OY												10
SARTORIUS BIOHIT LIQU...												
OPTOMED OY												
MEDIXINE OY												
EVONDOS OY												
TAMPERE TECHNOLOGY...										2		
MENDOR OY												
LOCUS GENEX OY												
ELEKTA NEUROMAG OY	1											
ELEKTA PUBL AB												
CLOTHING PLUS OY								1				
UPM-Kymmene Corp.												
SERRES OY												
ONCOS THERAPEUTICS												
MODZ OY												
FORENDO PHARMA LTD												
DELFIN TECHNOLOGIES ...												
VEGENICS LTD									5			
ABO AKADEMI UNIV		1										
PLANMED OY												
ONBONE OY												
HLD HEALTHY LIFE DEVI...												
FIRSTBEAT TECHNOLOG...												
BEDDIT OY												
SYNOSTE OY					2							
VALON LASERS OY												
TIOLAT OY												

Figure 14: Here the cooperation between companies can be seen. Mega Elektroniikka has made 5 patents in cooperation with Suunto and one with Clothing Plus. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.



Key Organizations/Assignees by Key Organizations/Assignees - © 2017 ACS on STN

	SARTORIUS BIOHIT LIQU...	OPTOMED OY	MEDIXINE OY	EVONDOS OY	TAMPERE TECHNOLOGY...	MENDOR OY	LOCUS GENEX OY	ELEKTA NEUROMAG OY	ELEKTA PUBL AB	CLOTHING PLUS OY	UPM-Kymmene Corp.	SERRES OY
GE HEALTHCARE FINLAND												
Thermo Fisher Scientific (I...												
VTT - Technical Research...					1							
POLAR ELECTRO												
PERKINELMER (Wallac)												
Nokia technologies												
PLANMECA OY												
HELSINKI UNIV					1							
BIOHIT	4						6					
PALODEX GROUP OY (Da...												
SUUNTO										1		
ORION DIAGNOSTICA												
NEXSTIM								1				
TURKU UNIV												
OULU UNIV												
BIORETEC OY												
AALTO UNIV												
STICK TECH OY												
MEDIX BIOCHEMICA												
MEGA ELEKTRONIIKKA										1		
Ludwig Institute for Cancer...												
TAMPERE UNIV					2							
VALKEE OY												
FARON PHARM OY												
SARTORIUS BIOHIT LIQU...	9											
OPTOMED OY		8										
MEDIXINE OY			8									
EVONDOS OY				8								
TAMPERE TECHNOLOGY...					7							
MENDOR OY						7						
LOCUS GENEX OY							6					
ELEKTA NEUROMAG OY								6	5			
ELEKTA PUBL AB								5	6			
CLOTHING PLUS OY										6		
UPM-Kymmene Corp.											6	
SERRES OY												6
ONCOS THERAPEUTICS												
MODZ OY												
FORENDO PHARMA LTD												
DELFIN TECHNOLOGIES ...												
VEGENICS LTD												
ABO AKADEMI UNIV					1							
PLANMED OY												
ONBONE OY												
HLD HEALTHY LIFE DEVI...												
FIRSTBEAT TECHNOLOG...												
BEDDIT OY												
SYNOSTE OY												
VALON LASERS OY												
TIOLAT OY												

Figure 15: Here the cooperation between companies can be seen. Biohit has common patents with Sartorius Biohit Liquid and Locus Genex (Sartorius acquired the liquid handling segment of Biohit in 2011). Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.

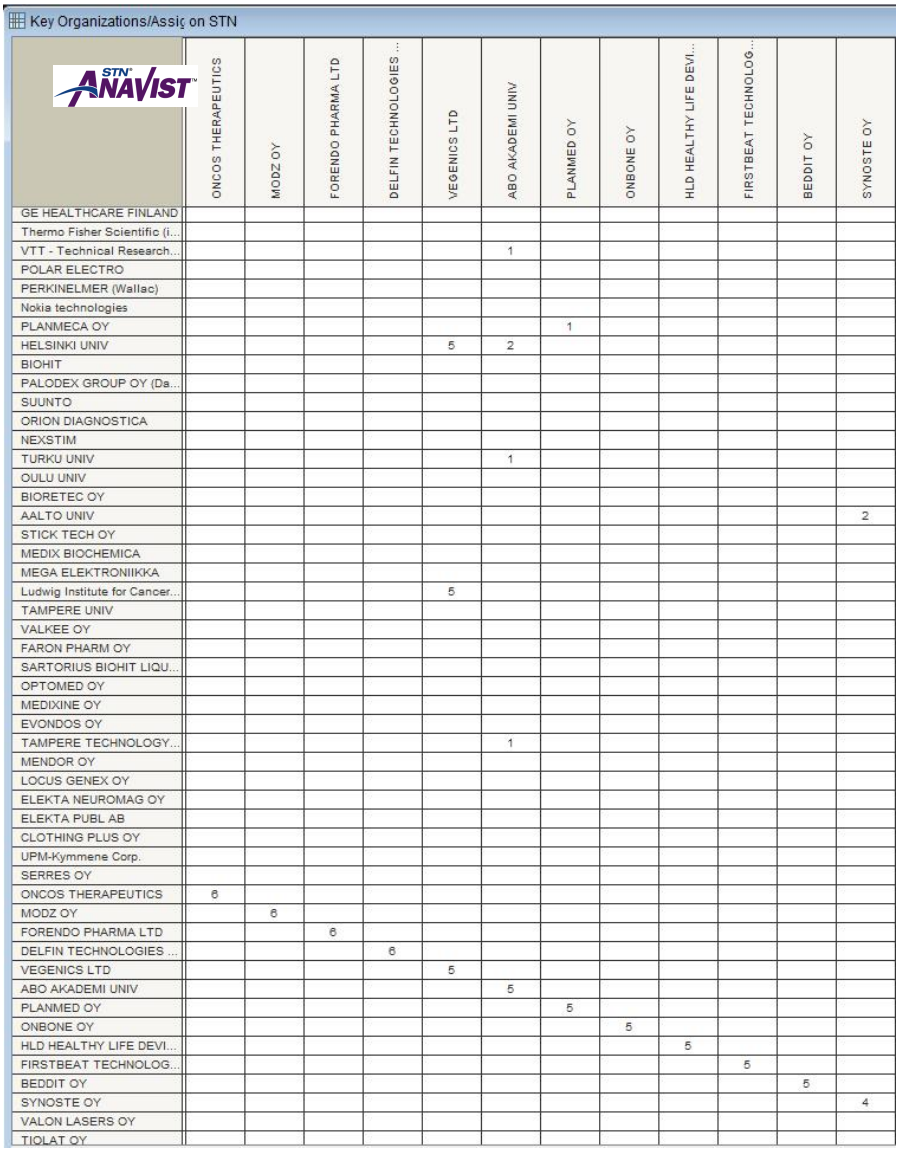


Figure 16: Here the cooperation between companies can be seen. Åbo Akademie has cooperation with VTT, Helsinki University, Turku University and Tampere University of Technology. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents database.

2.6 Year trends (priority publication years)

Figure 17 shows year trends of patent filings in the Finnish health/wellness sector. The columns for the last 1,5 years are incomplete since they contain only applications filed 18 months before the search was done. In this case the search was done on 4 May 2017. In addition, there can be delays before the indexed references enter the database. Therefore, it still takes almost three months before the whole year 2015 will be ready.

Patenting activity of Finnish health/wellness companies has grown since the 1990's. There are some declines during some years but the overall trend is increasing. There have been declines around 2000–2002 and then again when the newest financial crisis began in 2009, but after that a rather heavy increase. But it seems that 2015 will not have a significant increase compared to 2014.

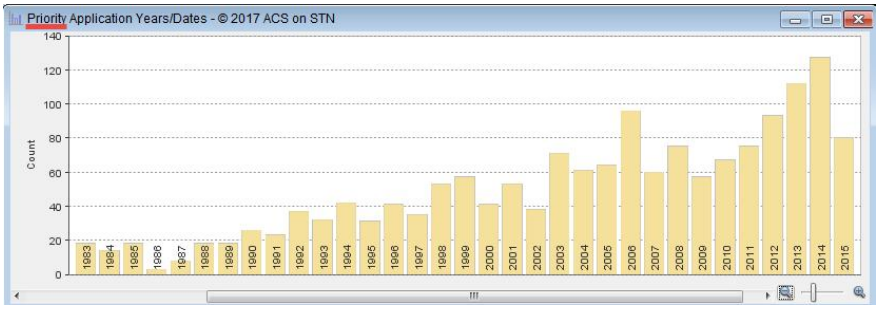


Figure 17: Year trends of patent documents in the Finnish health/wellness sector. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents Index database.

2.7 Key organizations by priority publication years

You can see here that Nokia Technologies has been most active in recent years (Figure 18). Also, Polar Electro has been active recently, as well as VTT and Thermo Fischer Scientific. After these Helsinki Univ, Suunto, Biohit and Turku Univ. VTT and Palodex have

been patenting rather steadily during all years. GE Healthcare Finland has only some patent publications during recent years, most of their patents are from the Instrumentarium time.

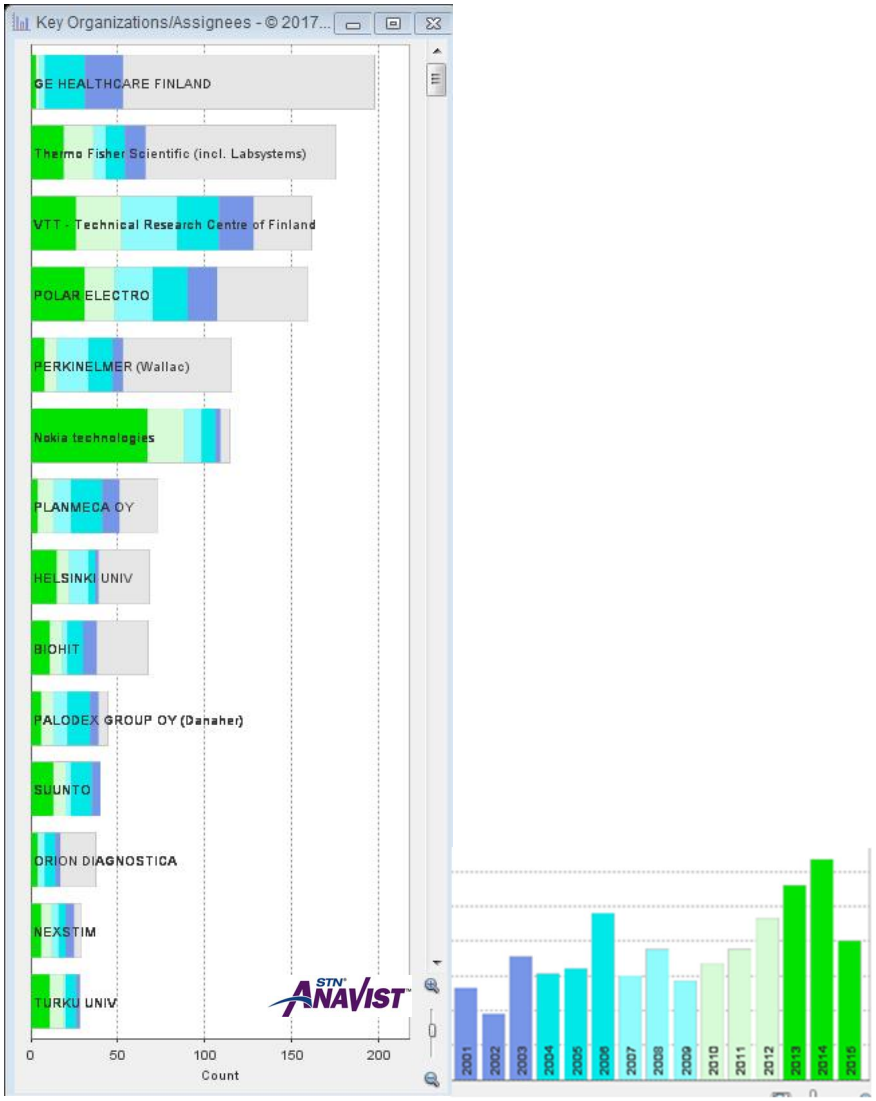


Figure 18: Trends of key organizations in Finnish health/wellness sector by priority publication years, colour coded as shown in the small picture. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents Index database.

2.8 Geographical business areas

Most patents have been applied to the USA during the years (Figure 19). Also, European Patent Office (EPO) has been popular, and PCT-applications are also used largely. Looking at the most recent priority years (2013–15, green on the right-hand side picture below) we can see that PCT-applications have lately been more popular than the US. Finland is fourth, and China has increased interest during the recent years.

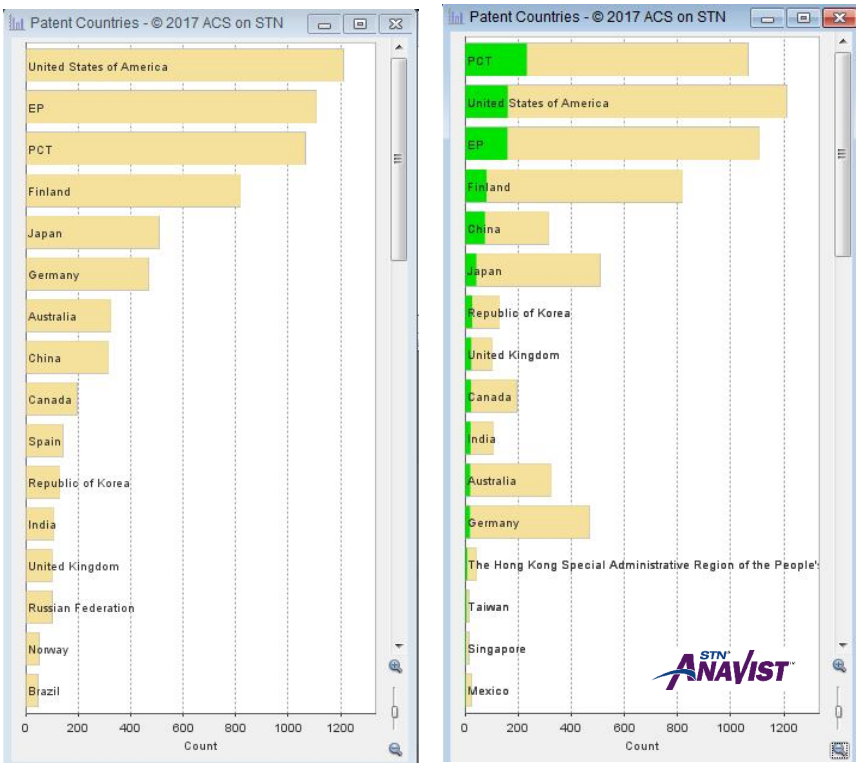


Figure 19: Most relevant geographical business areas in the Finnish health/wellness sector. Colouring: Priority years 2013–2015. Please note that the last 1,5 years are still incomplete. Visualization made by STN AnaVist of the 1722 documents retrieved from the Derwent Word Patents Index database.

2.9 Citations

Citation analysis (here forward citations, newer applications were examined) shows that there are many citations to these patents that were found in this search. Nokia (497 and 213 citations looking for the 10 most-citied patents) and Instrumentarium (201, 153 and 131 citations) have the most patents that are cited a lot among the 10 most-cited ones. The most-cited are from priority year 1991. Also, Onesys has one very frequently cited patent (338), applied in the same year (1991) when to company was founded.

As a whole about 25 % of the patent families were cited at least 10 times and only 25 % of these patent families were not cited at all, even though there are a lot of new patent applications included.

This means that Finnish companies have made key patents in this branch, so there are important inventions coming from Finland, or they have been frequently made especially in the 1990's. There are two patent families with rather many citations from the priority year 2004 and 2005 among the 30 most-cited patent families in this search. One of them is from Nokia (107), one from GE Healthcare (81), one from FIT Biotech Oy (79) and one from BCI Bioabsorbable Concepts Oy and Bioretec Oy together (74).

List of the 10 most-cited patents in this search; first the number of forward citations is listed followed by priority year (in brackets) and then the priority application number after it:

1) Nokia 497 (1996), FI 1996-636

2) Onesys 338 (1991) FI 1991-2520

3) Nokia 213 (1997) DE 1997-19745539

4) Instrumentarium 201 (1997) FI 1997-3454

5) Polar Electro 168 (1991) FI 1991-2487

6) Instrumentarium 153 (1995) FI 1995-5758

7) Wallac 151 (1987) SE 1987-2511

8) International Business Innovations Ltd. 138 (M Myllymäki) (1992) FI 1992-896

9) Datex Palomex (jointly with Instrumentarium) 131 (1981) FI 1981-1733

10) Instrumentarium 120 (1996) FI 1996-2448

2.10 Only the bigger companies

Visualization was also done so that only the six most active patenting organizations in this search were taken. In Figure 20 you can see the current landscape.

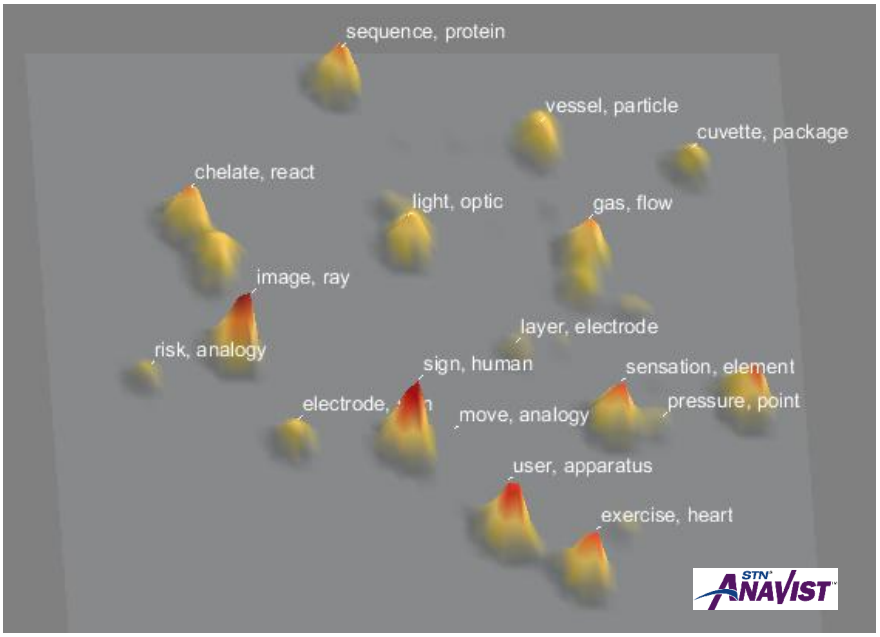


Figure 20: Topographic map of patent documents on the six largest organizations in this search in tilted form. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

GE Healthcare Finland

GE Healthcare Finland has been the most active organization in patenting found in this search (Figure 21 & Figure 22). Most of their patents are from before GE Healthcare acquired Instrumentarium; GE Healthcare bought Instrumentarium in 2003.

Patents have most frequently been applied for in the USA, but also actively in Finland. Germany and EP have a similar rate of patent application.

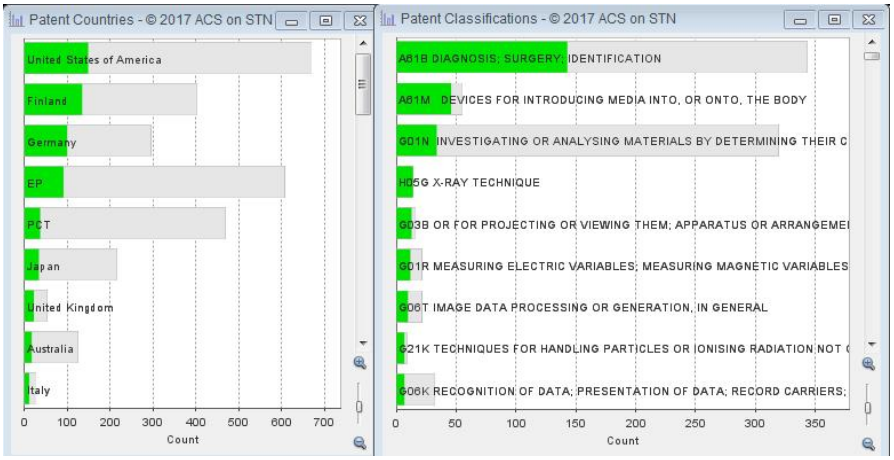


Figure 21: Patent countries and international patent classification of GE Healthcare Finland's patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

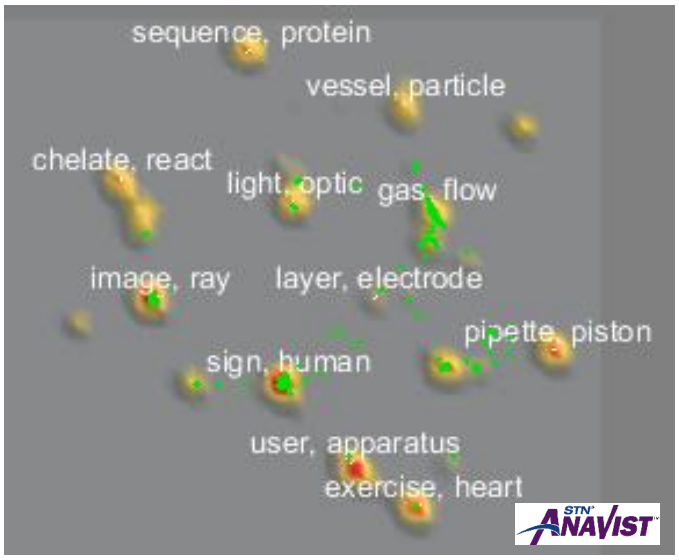


Figure 22: GE Healthcare patent families on the map, shown with green dots. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Here are the 10 most recent patent titles from GE Healthcare Finland (Figure 23). These are re-written by Derwent to explain more than the original title usually explains.

	Title	Label
1	Portable medical device for home health monitoring e.g. non-invasive blood pressure (N1BP) monitoring device, has control unit regulates control voltage and control current of valve as function of motion signals of inertial sensor. WPINDEX	2015, GE Healthcare
2	Verification method for verifying wireless devices connected to wireless medical body area network (MBAN) involves indicating multiple wireless devices connected to wireless MBAN by displaying indication on wireless devices. WPINDEX	2014, GE Healthcare
3	Method for associating e.g. sensors, with wireless medical body area network, involves displaying list on host of wireless devices, selecting wireless device on list, and associating selected wireless device on list with host. WPINDEX	2014, GE Healthcare
4	Wireless sensor for use in mainstream type gas analyzer, to measure concentration of carbon dioxide in breathing gas of patient, has electronics board to choose from first and second energy supply mode to radiation source. WPINDEX	GE Healthcare
5	Method for separating electrical measurement signals into breathing signals and ambulatory motion signals, involves performing multiple-input-multiple-output analog to information conversion of spatially pre-conditioned measurement signals. WPINDEX	GE Healthcare
6	Fluid delivery apparatus for use as nebulizer to discharge fluid i.e. anesthetic agent such as medicine, to patient, has vibrator in contact with plate through transmission unit, where unit transmits vibration effect from vibrator to plate. WPINDEX	GE Healthcare
7	Airway sensor for use by patients during e.g. anesthesia has sensor electronics common for flow measuring device for measuring respiratory gas flow and pressure measuring device for measuring respiratory airway pressure. WPINDEX	GE Healthcare
8	Reconstruction method of medical image of object, by using antipriori component for attenuating artifacts from medical image of object to be reconstructed. WPINDEX	GE Healthcare
9	Focal epileptiform activity detecting method for e.g. epileptic seizure, involves positioning electrodes to obtain time-domain brain wave signals, and providing indication of presence of activity based on signal-specific measures. WPINDEX	GE Healthcare
10	Physiological patient parameter e.g. urine expulsion, monitoring and analyzing system, has processor programmed to apply analysis rule to signal that represents urine expulsion, and database with analysis	GE Healthcare

0 Marked Documents 1 - 50 of 197 Page 1 of 4

Figure 23: Most recent Derwent-written titles of GE Healthcare Finland's patents found in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Most of the GE Healthcare Finland's patents were filed a rather long time ago. There are now some applications in 2012, 2014 and 2015 (Figure 24).

There can be some uncertainty in these; the databases do not necessarily change the owner of the patent due to acquisitions. There are still a lot of patents in the name of Instrumentarium. And because GE Healthcare Finland bought Instrumentarium in 2003, we have here combined both companies under the name of GE Healthcare Finland. Even though we do not know if all the patents have been part of the deal.

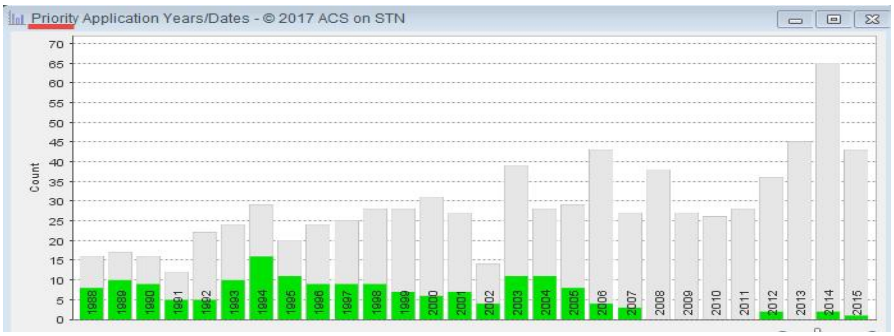


Figure 24: Priority application years of GE Healthcare Finland's patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Thermo Fisher Scientific

Thermo Fisher Scientific has applied for patents rather steadily in EPO, US, PCT, Finland Japan and Germany (Figure 25 – Figure 27).

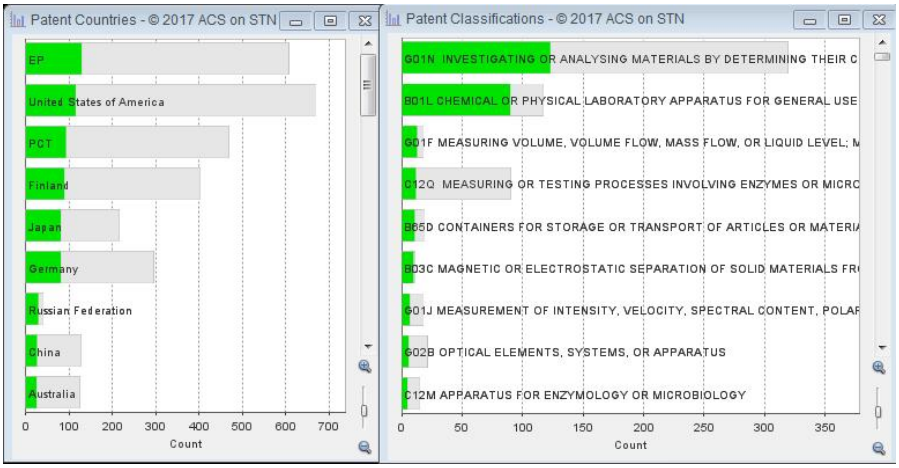


Figure 25: Patent countries and international patent classification of Thermo fisher Scientific's patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

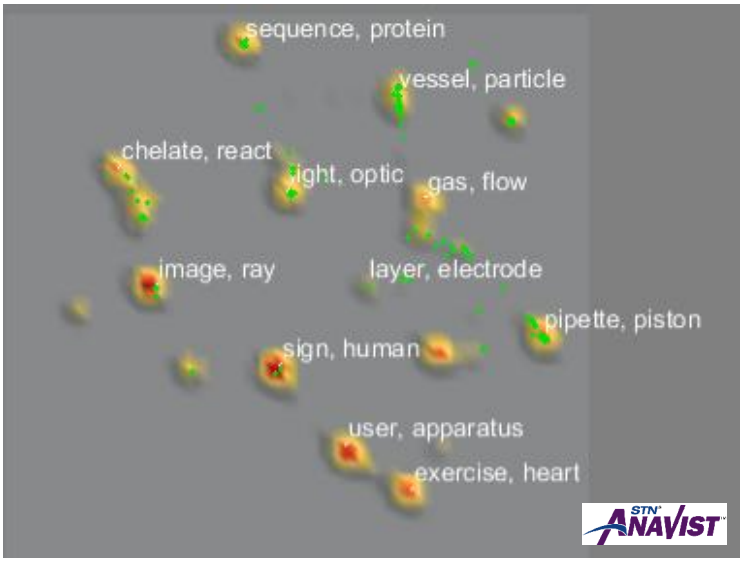
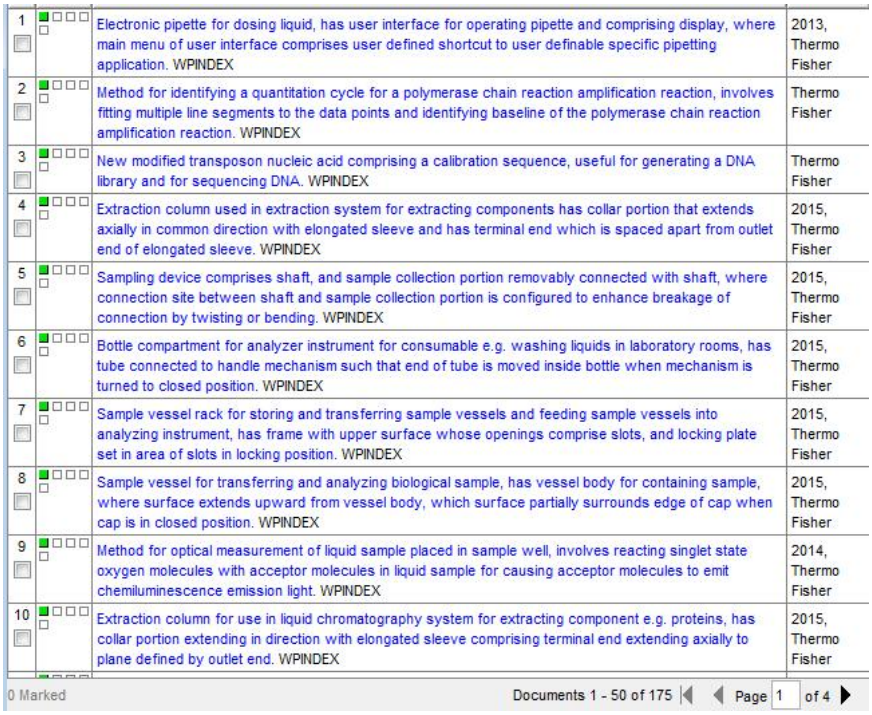


Figure 26: Thermo Fisher Scientific patent families on the map, shown by the green dots. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.



1		Electronic pipette for dosing liquid, has user interface for operating pipette and comprising display, where main menu of user interface comprises user defined shortcut to user definable specific pipetting application. WPINDEX	2013, Thermo Fisher
2		Method for identifying a quantitation cycle for a polymerase chain reaction amplification reaction, involves fitting multiple line segments to the data points and identifying baseline of the polymerase chain reaction amplification reaction. WPINDEX	Thermo Fisher
3		New modified transposon nucleic acid comprising a calibration sequence, useful for generating a DNA library and for sequencing DNA. WPINDEX	Thermo Fisher
4		Extraction column used in extraction system for extracting components has collar portion that extends axially in common direction with elongated sleeve and has terminal end which is spaced apart from outlet end of elongated sleeve. WPINDEX	2015, Thermo Fisher
5		Sampling device comprises shaft, and sample collection portion removably connected with shaft, where connection site between shaft and sample collection portion is configured to enhance breakage of connection by twisting or bending. WPINDEX	2015, Thermo Fisher
6		Bottle compartment for analyzer instrument for consumable e.g. washing liquids in laboratory rooms, has tube connected to handle mechanism such that end of tube is moved inside bottle when mechanism is turned to closed position. WPINDEX	2015, Thermo Fisher
7		Sample vessel rack for storing and transferring sample vessels and feeding sample vessels into analyzing instrument, has frame with upper surface whose openings comprise slots, and locking plate set in area of slots in locking position. WPINDEX	2015, Thermo Fisher
8		Sample vessel for transferring and analyzing biological sample, has vessel body for containing sample, where surface extends upward from vessel body, which surface partially surrounds edge of cap when cap is in closed position. WPINDEX	2015, Thermo Fisher
9		Method for optical measurement of liquid sample placed in sample well, involves reacting singlet state oxygen molecules with acceptor molecules in liquid sample for causing acceptor molecules to emit chemiluminescence emission light. WPINDEX	2014, Thermo Fisher
10		Extraction column for use in liquid chromatography system for extracting component e.g. proteins, has collar portion extending in direction with elongated sleeve comprising terminal end extending axially to plane defined by outlet end. WPINDEX	2015, Thermo Fisher

0 Marked Documents 1 - 50 of 175 Page 1 of 4

Figure 27: Most recent Derwent-written titles of Thermo Fisher Scientific patents found in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Thermo Fisher Scientific has been active for a long time over the years. These numbers in Figure 28 include also Labsystems patents even though we are not be sure if all of them were part of the deal when Thermo Fisher acquired Labsystems' life science part.

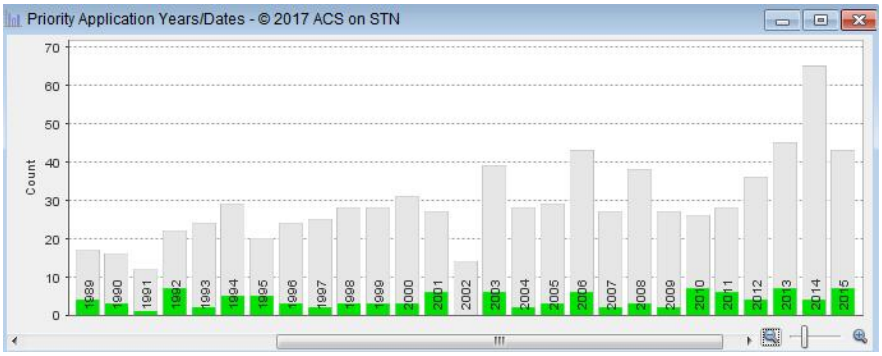


Figure 28: Priority application years of Thermo Fisher Scientific patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Polar Electro

Polar Electro has eagerly patented in the United States (Figure 29 – Figure 31). It has also shown interest in EPO and Finland.

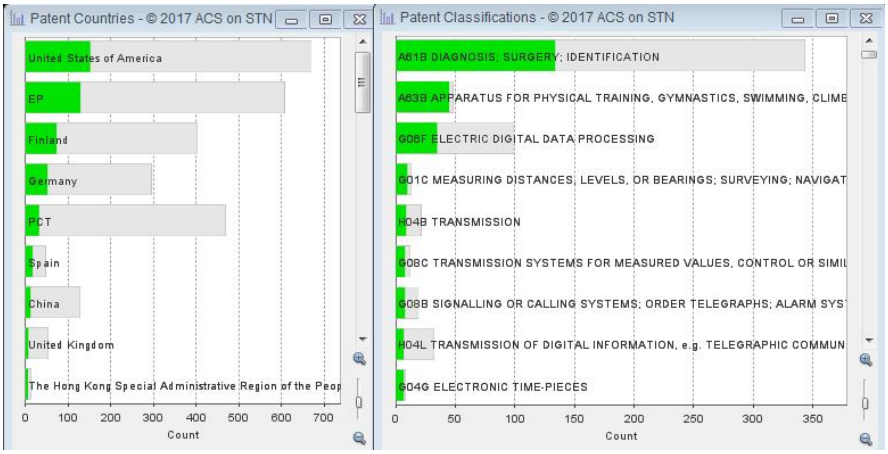


Figure 29: Patent countries and international patent classification of Polar Electro's patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

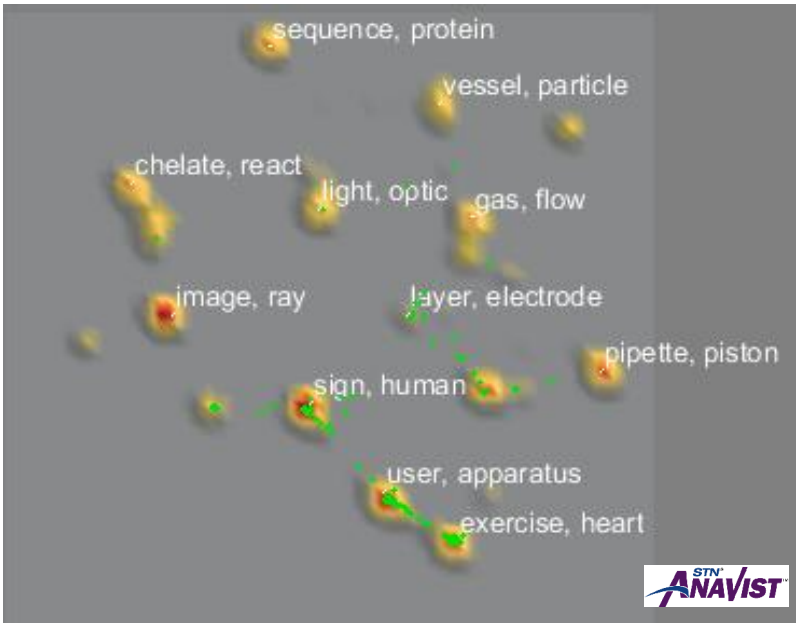
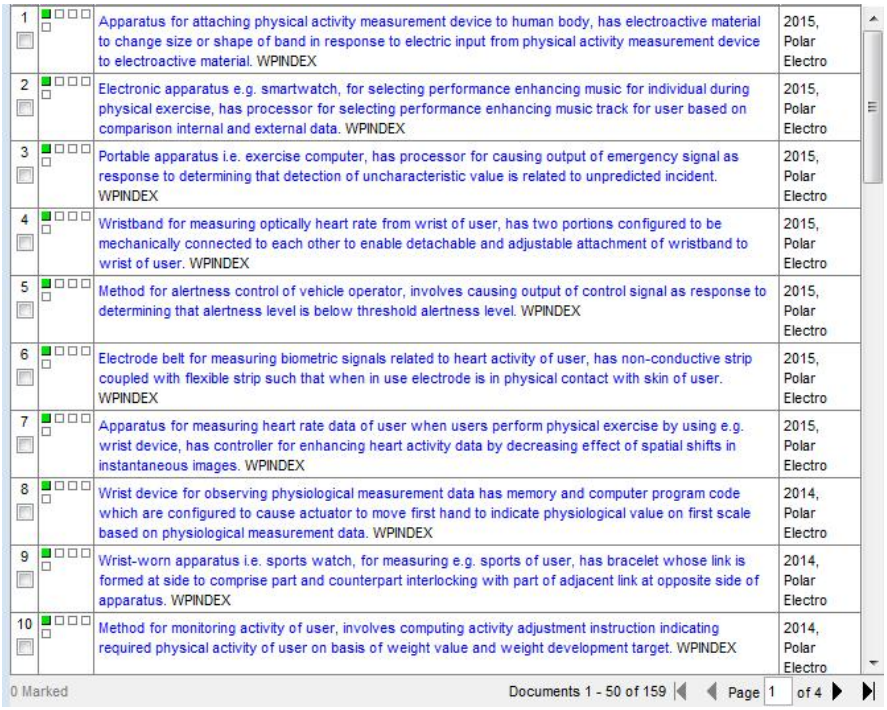


Figure 30: Polar Electro patent families on the map, shown by the green dots. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.



1	Apparatus for attaching physical activity measurement device to human body, has electroactive material to change size or shape of band in response to electric input from physical activity measurement device to electroactive material. WPINDEX	2015, Polar Electro
2	Electronic apparatus e.g. smartwatch, for selecting performance enhancing music for individual during physical exercise, has processor for selecting performance enhancing music track for user based on comparison internal and external data. WPINDEX	2015, Polar Electro
3	Portable apparatus i.e. exercise computer, has processor for causing output of emergency signal as response to determining that detection of uncharacteristic value is related to unpredicted incident. WPINDEX	2015, Polar Electro
4	Wristband for measuring optically heart rate from wrist of user, has two portions configured to be mechanically connected to each other to enable detachable and adjustable attachment of wristband to wrist of user. WPINDEX	2015, Polar Electro
5	Method for alertness control of vehicle operator, involves causing output of control signal as response to determining that alertness level is below threshold alertness level. WPINDEX	2015, Polar Electro
6	Electrode belt for measuring biometric signals related to heart activity of user, has non-conductive strip coupled with flexible strip such that when in use electrode is in physical contact with skin of user. WPINDEX	2015, Polar Electro
7	Apparatus for measuring heart rate data of user when users perform physical exercise by using e.g. wrist device, has controller for enhancing heart activity data by decreasing effect of spatial shifts in instantaneous images. WPINDEX	2015, Polar Electro
8	Wrist device for observing physiological measurement data has memory and computer program code which are configured to cause actuator to move first hand to indicate physiological value on first scale based on physiological measurement data. WPINDEX	2014, Polar Electro
9	Wrist-worn apparatus i.e. sports watch, for measuring e.g. sports of user, has bracelet whose link is formed at side to comprise part and counterpart interlocking with part of adjacent link at opposite side of apparatus. WPINDEX	2014, Polar Electro
10	Method for monitoring activity of user, involves computing activity adjustment instruction indicating required physical activity of user on basis of weight value and weight development target. WPINDEX	2014, Polar Electro

Figure 31: The most recent Derwent-written titles of Polar Electro's patents found in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

In Figure 32 you can see that Polar Electro has been on the market already for a long time and it has also filed patents during all years. Since 2012 it has again been more active in patenting.

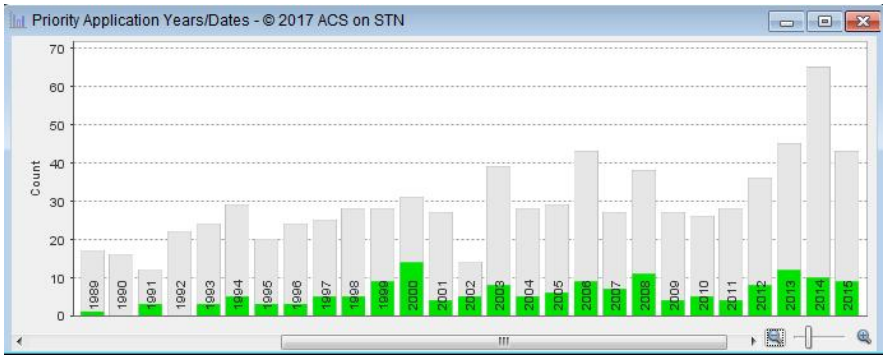


Figure 32: Priority application years of Polar Electro patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

PerkinElmer

PerkinElmer has filed patents in EPO and the USA and also made a PCT application (Figure 33 – Figure 35).

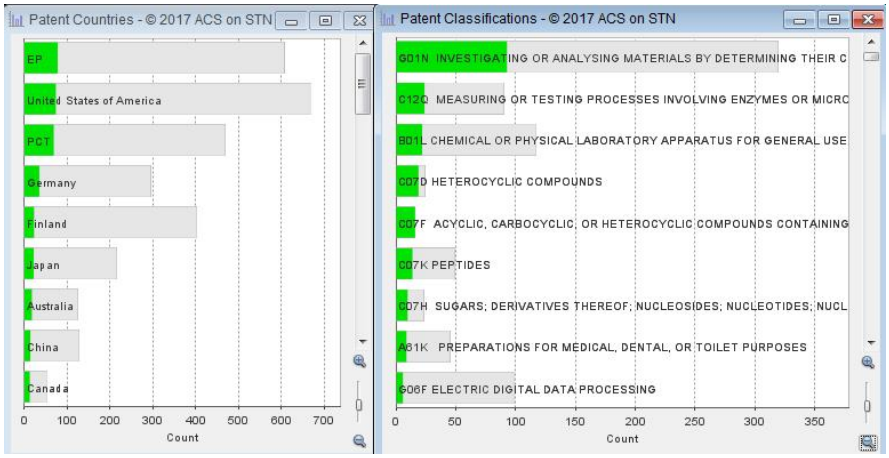


Figure 33: Patent countries and international patent classification of PerkinElmer's patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

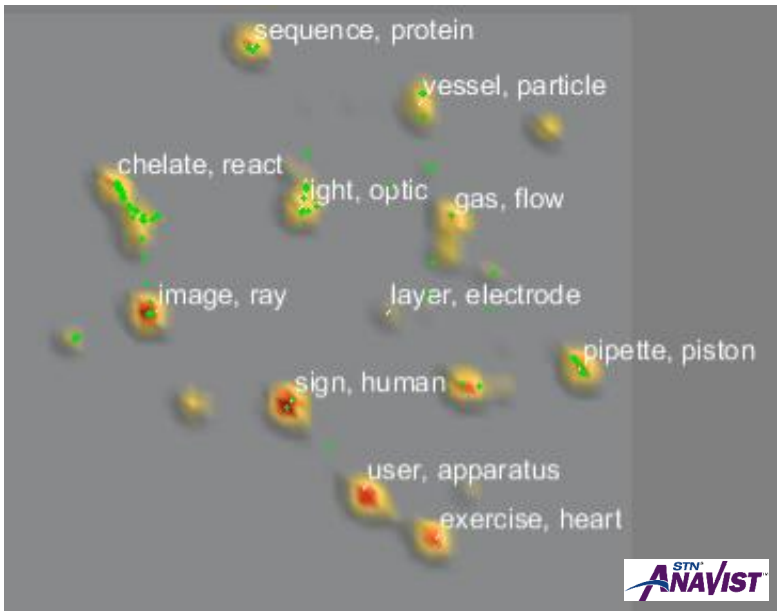
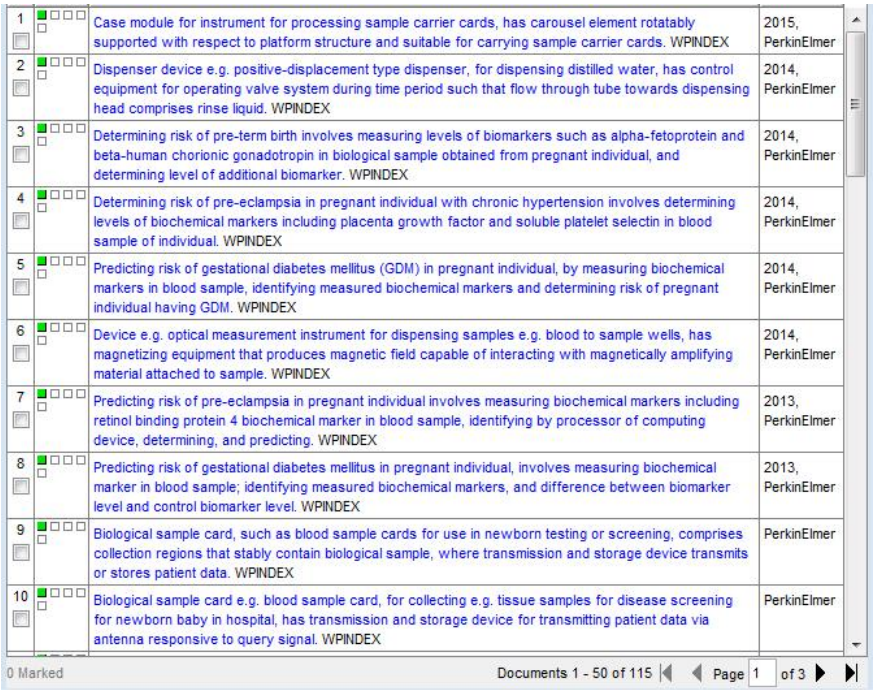


Figure 34: PerkinElmer patent families on the map, the green dots. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.



1		Case module for instrument for processing sample carrier cards, has carousel element rotatably supported with respect to platform structure and suitable for carrying sample carrier cards. WPINDEX	2015, PerkinElmer
2		Dispenser device e.g. positive-displacement type dispenser, for dispensing distilled water, has control equipment for operating valve system during time period such that flow through tube towards dispensing head comprises rinse liquid. WPINDEX	2014, PerkinElmer
3		Determining risk of pre-term birth involves measuring levels of biomarkers such as alpha-fetoprotein and beta-human chorionic gonadotropin in biological sample obtained from pregnant individual, and determining level of additional biomarker. WPINDEX	2014, PerkinElmer
4		Determining risk of pre-eclampsia in pregnant individual with chronic hypertension involves determining levels of biochemical markers including placenta growth factor and soluble platelet selectin in blood sample of individual. WPINDEX	2014, PerkinElmer
5		Predicting risk of gestational diabetes mellitus (GDM) in pregnant individual, by measuring biochemical markers in blood sample, identifying measured biochemical markers and determining risk of pregnant individual having GDM. WPINDEX	2014, PerkinElmer
6		Device e.g. optical measurement instrument for dispensing samples e.g. blood to sample wells, has magnetizing equipment that produces magnetic field capable of interacting with magnetically amplifying material attached to sample. WPINDEX	2014, PerkinElmer
7		Predicting risk of pre-eclampsia in pregnant individual involves measuring biochemical markers including retinol binding protein 4 biochemical marker in blood sample, identifying by processor of computing device, determining, and predicting. WPINDEX	2013, PerkinElmer
8		Predicting risk of gestational diabetes mellitus in pregnant individual, involves measuring biochemical marker in blood sample; identifying measured biochemical markers, and difference between biomarker level and control biomarker level. WPINDEX	2013, PerkinElmer
9		Biological sample card, such as blood sample cards for use in newborn testing or screening, comprises collection regions that stably contain biological sample, where transmission and storage device transmits or stores patient data. WPINDEX	PerkinElmer
10		Biological sample card e.g. blood sample card, for collecting e.g. tissue samples for disease screening for newborn baby in hospital, has transmission and storage device for transmitting patient data via antenna responsive to query signal. WPINDEX	PerkinElmer

Figure 35: Most recent Derwent-written titles of PerkinElmer's patents found in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

PerkinElmer's activity in patenting has changed over the years (Figure 36). Every now and then is a year with more patent applications and then again rather quiet. During 2003–08 they were more active, and more recently 2014 has been an active year, while 2015 seems to be rather quiet.

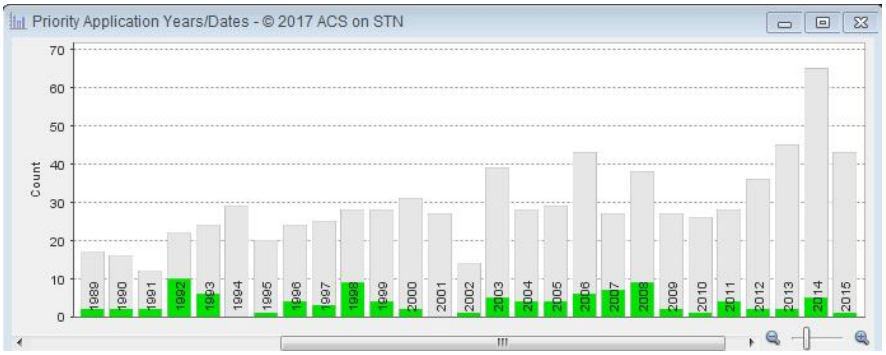


Figure 36: Priority application years of PerkinElmer patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Nokia Technologies

Nokia Technologies makes PCT applications and applies for patents with the EPO and USA (Figure 37 – Figure 39). They do not apply to Finland directly.

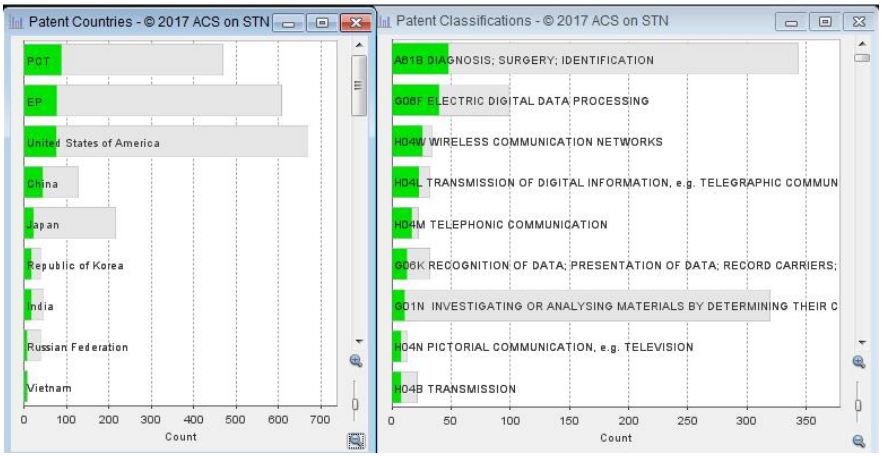


Figure 37: Patent countries and international patent classification of Nokia Technologies' patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

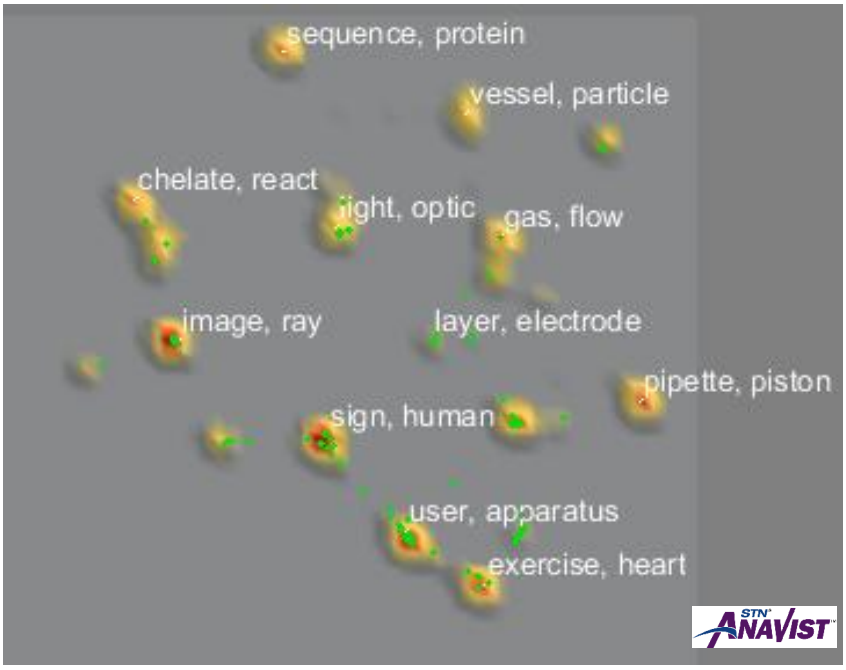


Figure 38: Nokia Technologies patent families on the map, shown as green dots. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

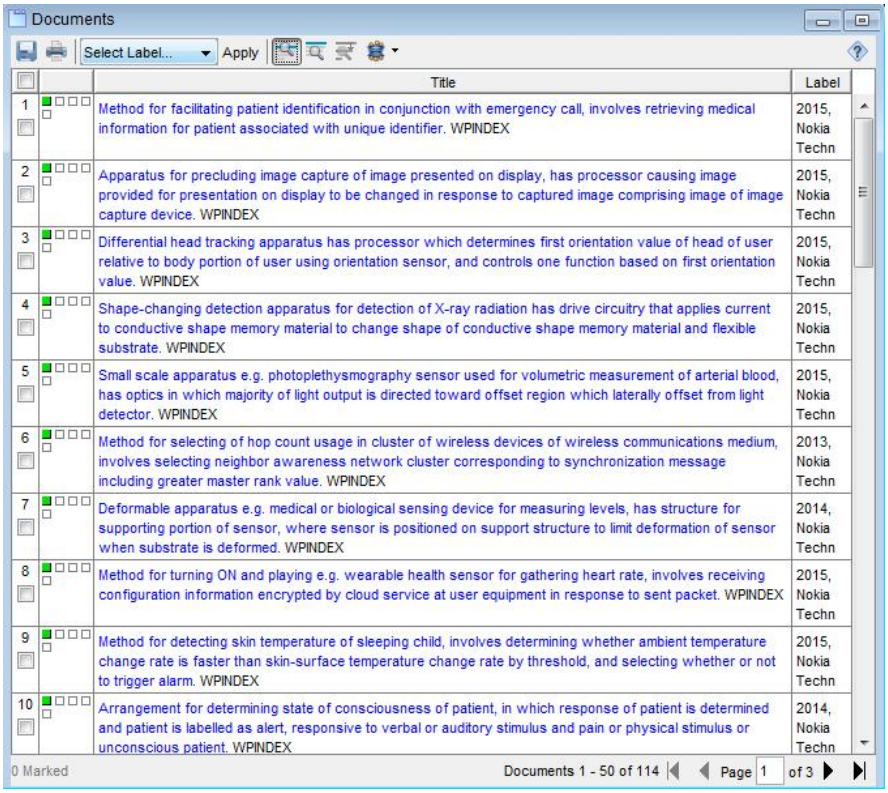


Figure 39: Most recent Derwent-written titles of Nokia Technologies' patents found in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

Nokia Technologies seems to have been very active lately in patenting, especially since 2012 (Figure 40). 2014 was a very active year and they have continued filing patents actively in 2015.

Figure 40: Priority application years of Nokia Technologies patents in this search. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index.

User, apparatus-cluster

Looking at one cluster in more detail (green dots in Figure 41) you can notice that Polar Electro have been most active here.

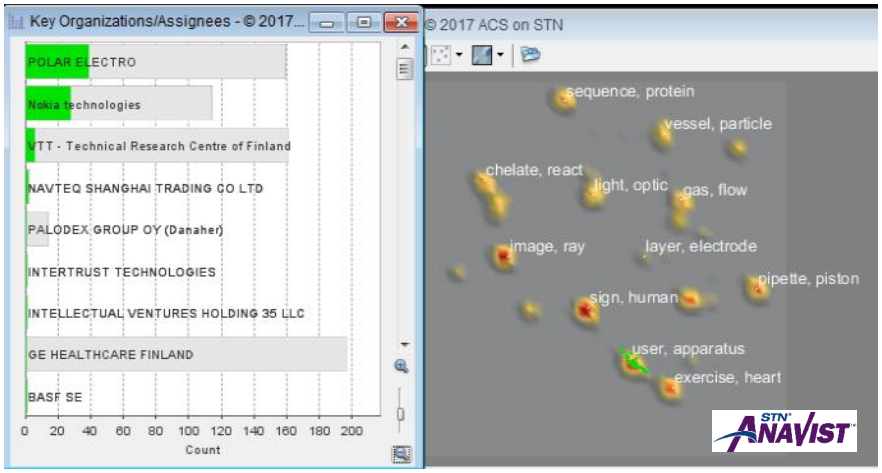


Figure 41: Looking at the user and apparatus-cluster in more detail. Polar Electro has been most active here. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

In Figure 42 are the priority application years for this cluster. Filing activity has grown since 2012. The most recent priority applications in this cluster are in Figure 43.

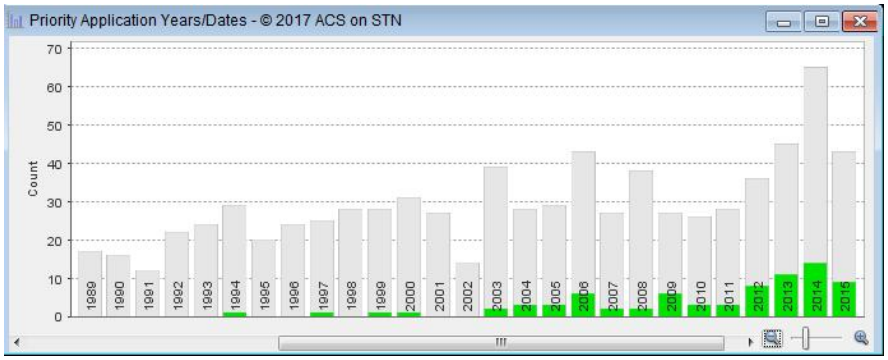
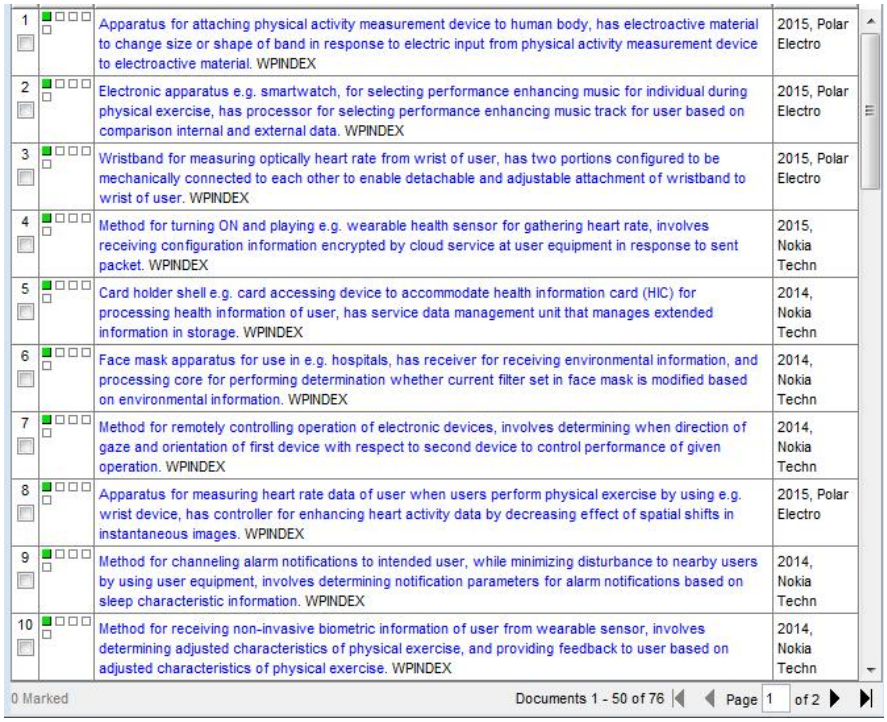


Figure 42: Looking at the user and apparatus-cluster in more detail. There has been a lot of activity since 2012. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.



1		Apparatus for attaching physical activity measurement device to human body, has electroactive material to change size or shape of band in response to electric input from physical activity measurement device to electroactive material. WPINDEX	2015, Polar Electro
2		Electronic apparatus e.g. smartwatch, for selecting performance enhancing music for individual during physical exercise, has processor for selecting performance enhancing music track for user based on comparison internal and external data. WPINDEX	2015, Polar Electro
3		Wristband for measuring optically heart rate from wrist of user, has two portions configured to be mechanically connected to each other to enable detachable and adjustable attachment of wristband to wrist of user. WPINDEX	2015, Polar Electro
4		Method for turning ON and playing e.g. wearable health sensor for gathering heart rate, involves receiving configuration information encrypted by cloud service at user equipment in response to sent packet. WPINDEX	2015, Nokia Techn
5		Card holder shell e.g. card accessing device to accommodate health information card (HIC) for processing health information of user, has service data management unit that manages extended information in storage. WPINDEX	2014, Nokia Techn
6		Face mask apparatus for use in e.g. hospitals, has receiver for receiving environmental information, and processing core for performing determination whether current filter set in face mask is modified based on environmental information. WPINDEX	2014, Nokia Techn
7		Method for remotely controlling operation of electronic devices, involves determining when direction of gaze and orientation of first device with respect to second device to control performance of given operation. WPINDEX	2014, Nokia Techn
8		Apparatus for measuring heart rate data of user when users perform physical exercise by using e.g. wrist device, has controller for enhancing heart activity data by decreasing effect of spatial shifts in instantaneous images. WPINDEX	2015, Polar Electro
9		Method for channeling alarm notifications to intended user, while minimizing disturbance to nearby users by using user equipment, involves determining notification parameters for alarm notifications based on sleep characteristic information. WPINDEX	2014, Nokia Techn
10		Method for receiving non-invasive biometric information of user from wearable sensor, involves determining adjusted characteristics of physical exercise, and providing feedback to user based on adjusted characteristics of physical exercise. WPINDEX	2014, Nokia Techn

Figure 43: The ten most recent Derwent-titles for the patent publications on the user and apparatus cluster. Visualization made by STN AnaVist of the 921 documents retrieved from the Derwent Word Patents Index database.

2.11 Only the smaller companies

When the six biggest organizations were taken out of this search, 801 patent families were left. In Figure 44 the most active organizations from these can be seen. The colours are according to priority years, as can be seen on the picture.

Planmeca has been most active over the years but have not been patenting that much during recent years. Helsinki University, Suunto and Turku University have been the most active during the years 2013–15.

These smaller companies have filed PCT applications more actively, whereas the bigger ones have preferred the USA. Interest in China has grown during recent years.

Figure 44: The biggest patent applicants in this search when the six organizations that have more than 100 patent families were left out. Planmeca has been the most active, but in recent years Helsinki University has been the most active. This information is based on 801 documents retrieved from the Derwent Word Patents Index database.

2.12 Validation of results

Those patent applications that are only applied for in Finland come rather slowly to the database used, but it is otherwise a good-quality database so it was taken as a source even though it is probably incomplete.

2.13 Conclusions

It seems that patenting has been quite active already for some time in this sector in Finland. There was activity already in the 1970's and in the 1990's the activity has grown rather steadily. There was a little decline during the last financial crisis, but patenting has recovered and has grown a lot since 2009.

This report is not a full and exact picture of this field in Finland, because the field is so widely spread that it is difficult to get a hold of. But there are over 300 organizations in this analysis that has IPR in this field. About 12 % of the organizations have more than five patent families so the most of the organizations are small companies. So there are a lot of players in this field also in Finland. Also, bigger global companies are interested of Finland, GE Healthcare and PerkinElmer are big players in Finland.

When we look at the geographical areas, the USA has been of most interest during the years, but if we look at recent years only PCT-filings are on top. That means that companies have nowadays a broader interest than only in the USA. US- and EP-filings come after PCT with about same number of applications. When looking at the smaller players, PCT-applications have been of most interest all the time, so they have not only been interested in the USA markets.

Organizations also apply for patents together. Most of the cooperation is between universities and companies but also some companies apply for patents together.

Of the patents analysed, about 25 % of the patent families were cited at least 10 times and only 25 % of these patent families were not cited at all, even though there are a lot of new patent applications included.

2.14 Summary

ORGANIZATIONS: GE Healthcare Finland has been the most active in patenting in Finland in this search. There are rather many old patents from before GE's acquisition of Instrumentarium. Thermo Fisher Scientific has also been active. They have also a lot of old patents from Labsystems. Polar Electro came in third. They have been patenting steadily over the years, rather much also during the last few years. PerkinElmer is the next one; its patents in Finland come from Wallac. Sixth is Nokia technologies, having the most patents from the last few years found in this search.

YEAR TRENDS: There has been activity in this branch already since the 1970's. Since 1990 the activity has grown rather steadily. 2002 seems to be a bit more quiet than other years and 2006 seems here to be a peak year. After 2009's minor decline, the growth in patenting has been rather heavy. Years indicated are priority years, meaning that it is the year when the first patent application concerning one invention has been filed.

GEOGRAPHICAL TRENDS: Most patents have been applied to the USA. Also, EPO has been popular, and PCT applications are also used largely. Finland is fourth, then comes Japan, Germany, Australia and China. Other companies have applied rather actively also in Finland but Nokia technologies have mainly applied in the USA.

3. Kalewa Ecosystem: Description and Objectives

The aim of the Pre-Kalewa II project is to propose a foundation for the Finnish Ecosystem of Integrated Digital Health and Wellness (later referred to as Kalewa Research). This section describes a plan for the **Kalewa ecosystem** itself, i.e. a proposal including the ecosystem's operational model and main building blocks identifying the partners and their roles in the ecosystem in addition to the Kalewa programme portfolio overview for years 2018–2021. An ecosystem is a dynamic and continuously evolving network of stakeholders: open platforms and interfaces enable actors to create their products and services in an evolutionary manner. This section will only propose one scenario as a starting point for the Kalewa ecosystem – its success will be proven by the innovative and potentially disruptive business creation it will deliver beyond what can be foreseen as of today. As with any modern ecosystem, Kalewa cannot be an isolated exercise but rather a part of the larger national and international networks operating under the thematic area of digital health and wellness. Hence, specific attention is given to the most prominent networks Kalewa should be aware of to co-operate with for even larger societal impact and business creation potential. A proposal for the funding structure is presented with a description of the most important funding sources that could be utilized by the Kalewa ecosystem.

3.1 Methods

This report is the deliverable of Task 4 of the final version of the Pre-Kalewa II project plan. A public open consultation with public sector and commercial health and wellness actors in Finland was conducted between March 20–24 2017 using workshops in five cities (Oulu, Jyväskylä, Tampere, Turku and Helsinki area). Additionally, bilateral meetings with key stakeholders were conducted to seek practical experience and recommendations based on best practices from past programme instruments with the intention to apply them in this specific thematic context. Further, a literature analysis of related publications in national and international contexts was conducted to identify the most recent trends and recommendations that could be taken on board for the Kalewa ecosystem.

3.2 Introduction

Various ecosystems play important roles in economic development and innovation activities. New innovations are key to economic regeneration. The rapid increase in the volume and availability of information, the evolution of communication technologies, and the globalization of value networks have changed the way innovations are created. These developments have increased the importance of co-operation and openness in innovation activities. The refinement of ideas into new products and services increasingly takes place through network-based interaction between multiple actors. These tight-knit, interdependent networks are called ecosystems.[11]

An ecosystem is always unique – each ecosystem consists of a unique set of actors and interactions and thereby evolves in its own manner. For the purpose of this document, ecosystems are viewed as structures of and relationships between interacting actors. The decisions and the related actions that are taken throughout the evolution of an ecosystem also shape its present and future state, as each decision provides raw material for subsequent decisions. Thus, ecosystems are dynamically evolving through interactions between ecosystem actors and should not be perceived from a deterministic or linear viewpoint. Furthermore, the economic ecosystem may consist of both networks of multiple firms and individuals, who are participating through different interaction mechanisms.[12]

There is a different logic of action in the different ecosystem types and the same actor can be involved and play different roles in each ecosystem (Figure 45). From the viewpoint of each individual actor, the interaction area between the ecosystem types and their relationships are different. Thus, highly mobile actors, platform owners, or keystone companies are examples of actors boosting the interaction between the ecosystem types. On the other hand, a platform – an organization of things such as technologies or complementary as-

[11] Antti Kaihovaara, Katri Haila, Kirsi Noro, Vesa Salminen, Valtteri Härmälä, Kimmo Halme, Kari Mikkelä, Veli-Pekka Saarnivaara, Henrik Pekkala: Innovaatioekosysteemit elinkeinoelämän ja tutkimuksen yhteistyön vahvistajina, Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 28/2017.

[12] Katri Valkokari: Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them, Technology Innovation Management Review, Aug 2015 (Vol 5, Issue 8), pp. 17-24.

sets – also may be the interconnecting factor between the ecosystems. Because of these interconnectivity actors and platforms, ecosystems do interact and therefore are evolving and emerging next to each other[12].

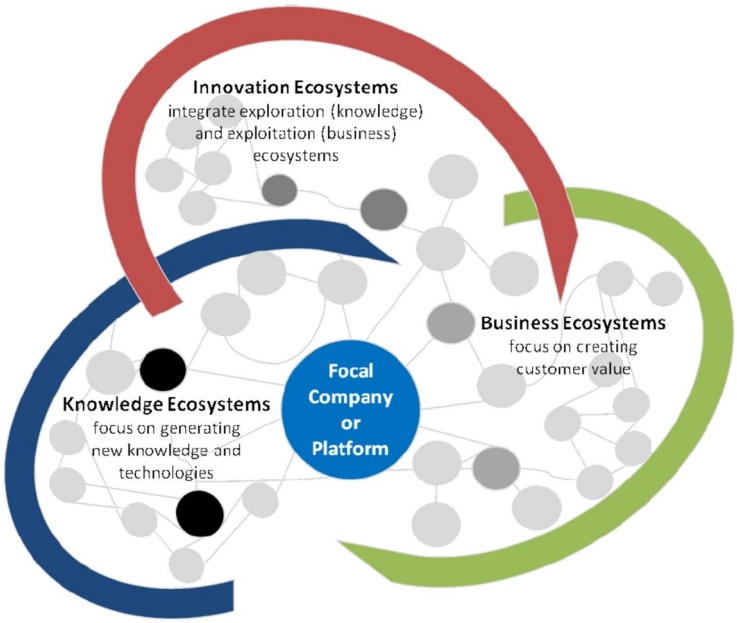


Figure 45: Relationships between overlapping ecosystem types.[12]

Table 1 summarizes the differences between the three ecosystem types in terms of their outcomes, interactions, actor roles, and logic of action.

	Business ecosystems	**Innovation ecosystems**	**Knowledge ecosystems**
Baseline of ecosystem	Resource exploitation for customer value	Co-creation of innovation	Knowledge exploration
Relationships and connectivity	Global business relationships both competitive and cooperative	Geographically clustered actors, different levels of collaboration and openness	Decentralized and distributed knowledge nodes, synergies through knowledge exchange
Actors and roles	Suppliers, customers, and focal companies as a core, other actors more loosely involved	Innovation policymakers, local intermediators, innovation brokers, and funding organizations	Research institutes, innovators, and technology entrepreneurs serve as knowledge nodes
Logic of action	A main actor that operates as a platform sharing resources, assets, and benefits or aggregates other actors together in the networked business operations	Geographically proximate actors interacting around hubs facilitated by intermediating actors	A large number of actors that are grouped around knowledge exchange or a central non-proprietary resource for the benefit of all actors

Table 1: Characteristics of ecosystem types.[12]

Business ecosystems focus on present customer value creation, and the large companies are typical key players within them. Knowledge ecosystems focus on the generation of new knowledge, and in this way research institutes and innovators, such as technology entrepreneurs, play central roles in these ecosystems. Innovation ecosystems occur as an integrating mechanism between the exploration of new knowledge and its exploitation for value co-creation in business ecosystems. Thus, innovation policymakers, local intermediators, innovation brokers, and funding organizations (such as venture capitalists or public funding agencies) are salient actors in innovation ecosystems. All these ecosystems are dynamic, changing, and also changeable through ecosystem orchestration. Different actors are

necessary to keep the ecosystem balanced, and removing one can cause a chain reaction felt throughout the entire ecosystem[12].

The Kalewa ecosystem is foreseen to touch all three ecosystems as defined above: the focus of activities within the priorities as identified in the Kalewa SRA, however, can naturally fall under a narrower ecosystem basis depending on the individual focus of a specific activity. To be able to support this, the operational model for the Kalewa Ecosystem should be planned accordingly.

3.3 Operational model

A clear finding and recommendation in a recent report regarding the creation of an ecosystem and the supporting operational model is that the creation mechanism and overall goals can be very different from each other[11]. Therefore, the operational model must be tailored to meet the specific needs of the Kalewa ecosystem within the thematic area of digital health and wellness. As described in sections 1 and 2 on the relevant Industry Actors & IPR, it can be seen that the Health Tech Industry in Finland is mostly driven by a rather limited number of large companies with only a few mid-sized players showing a very strong correlation of volume of business and amount of IPR. In addition, a large number of smaller companies are present but the volume of the business is rather small.

The public consultations clearly raised concerns regarding the possibilities for smaller companies and organizations to participate in the activities of the Kalewa ecosystem: a key enabler there is access to data and possibilities to participate in Proof of Concept (PoC) activities with the other relevant actors to be able to develop and test their products and services in a realistic operational environment to reach their first references. Clearly, smaller companies and organizations do not have the resources to create the data or PoC environment by themselves and usually require other partners to test their product or service concepts[13]. Therefore, the ecosystem must be able to create and maintain the necessary means to support these requirements on behalf of the smaller companies as part of the operational model.

The overall operational environment in the field of healthcare and wellness is overly complex: it is characterized by a number of public

[13] Mari Hjelt, Susanna Sepponen, Santeri Palomäki, Päivi Luoma: Julkiset tutkimusinfrastruktuurit ja kehitysympäristöt elinkeinoelämän käytössä. Tekes Review 336/2017, Helsinki 2017.

sector actors with varying and overlapping responsibilities. Also, the public sector of healthcare is currently under major reform (SOTE revision). From the Kalewa Ecosystem point of view this imposes a risk of insufficient coordination between the actors which may lead to isolated silos of activities without proper coordination at the national level. Further, it was pointed out during the consultations that within this thematic area a long-term, business-driven and stable environment is needed to avoid interruptions in strategic coordination or availability of public funding, therefore calling for a separate independent actor to coordinate the activities of the Kalewa Ecosystem.

Best practices from the Finnish R&I programmes

A thorough summary of the evolution of the public funded R&I activities in Finland is presented in a recent report[11] with key findings of the most recent operational models as well. The evolution from the project/programme approach towards to PPP (Public Private Partnership) operational models has delivered interesting best practices applicable to the national needs which should be considered when planning the operational model for the Kalewa Ecosystem:

- Public funding incentives have been an efficient means to further co-operation.

- Programme instruments have been successful in creating co-operation networks and supporting open innovation, but lacking in early-stage interaction and creation of value networks.

- The SHOK instrument was successful in strengthening the national knowledgebase and early-stage interaction but was lacking in creating open innovation or value networks especially in areas with short time to market.

- The INKA programme has been successful in endorsing national and international networking.

- The number of research results with commercial potential by the universities and research organizations is low and the creation of common structures and functions seems rational to enhance commercialization of research results.

- Even though the companies should be given a strong say in the definition of the strategic priorities, also the strategic choices and

priorities of the public sector actors are needed to ensure the impact on the Finnish economy, especially in terms of the timespan, which is typically short for the companies.

- Ecosystems are complicated entities where the actors should have a sufficient degrees of freedom and where the top-down guidance should be limited to a minimum. The process to choose the operational model for the ecosystem should be a combination of the top-down and bottom-up processes.

From the above, it can be concluded that to strengthen co-operation and create new business from the R&I activities, the goal should be new products and services which have international market potential to avoid competition limited to a national market between the partners of the Kalewa ecosystem. Also, the operational model should not be defined in too much detail top-down, rather it should be left for the consortium to decide. However, the strategic guidance and priorities should follow the interest of the public sector actors in a balanced manner between business interests and expected impact on Finnish society.

Although the concept of PPPs is not new, a novel form of strategic PPPs addressing specific challenges in industry or technology sectors are increasingly emerging. Compared to the traditional PPPs, strategic PPPs have a longer-term duration for public-private co-operation, e.g. at least four years of public funding support. These PPPs usually involve a minimum of three partners and tend to require large funding commitments from partners over the lifespan of the PPP[14]. A good example of a recent activity following this model is the creation of the Rolls-Royce global research and development centre for the advancement of remote controlled and autonomous shipping technology in Turku.

OECD Recommendations

These trends, findings and recommendations are also supported by many of the indicative recommendations of the OECD review of the Finnish innovation system:[15]

[14] OECD "Strategic public/private partnerships", in OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.
[15] OECD Reviews of Innovation Policy: Finland 2017, Draft Overall Assessment and Recommendations, 30 January 2017.

- Improve steering and impact of research and innovation policy by supporting stakeholder coordination and their innovation agenda setting, and implementation of their strategic research and innovation agendas. This entails using new instruments for linking a wide range of relevant actors (knowledge producers, users, intermediaries, and others) for addressing industrial innovation and societal challenges.

  - In doing so, develop a new model for public-private partnerships that does not only tackle research but also seeks broader innovation goals by including downstream areas – translational research, product testing and technology diffusion and commercialization of innovation – and wider set of stakeholders such as innovation users and regulatory agencies.

- Strengthen policy learning and design through experimentation. This will entail experimenting in both (new) governance mechanisms (e.g. second-layer of coordination both horizontal and vertical) for strategy articulation and implementation, as well as in launching new coordination and public-private partnerships programmes (PPPs) for innovation.

- Launch a new and reinforced programme for public-private partnerships for societal challenges that will enable coordination not only for research and innovation via jointly agreed strategic research and innovation agendas, but also for involving the other stakeholders whose engagement is needed in order to achieve systems transitions. This should be done in a competitive setting to ensure that they address areas where there is both opportunity and a viable set of partners willing to commit resources.

Further, a three-pronged approach is needed to foster productivity and innovation in businesses:

- First, investment in research and innovation should be reinforced but with a new approach that is aimed more at the development and adoption of “radical” innovation and new technological solutions for building new competitive advantages in both existing and new industries. This should also include the pursuit of technologies and business models that enable companies to upgrade business and shift from existing activities to new, related ones.

- Second, and closely-related to the previous objective, larger-scale initiatives for research and innovation needs in industries should be launched, allowing for a wider involvement of innovation actors and facilitating a more ambitious medium- to long-term innovation agenda coordinated within networks. The purpose is to revitalize industries through radical innovation and wider strategic (economic-challenge driven) innovation agendas. A new type of strategic (challenge-driven) public-private partnerships (PPPs) should be established based on new models of governance and operation.

- Third, special provisions should be made to encourage (new and existing) SMEs to innovate and enter markets. All three elements need to be combined for making both new and existing industries more dynamic. Finally, efforts should be geared towards providing better growth opportunities for firms through value creation networks and internationalization.

- Launch a new and reinforced programme for PPPs for research and innovation that will enable coordination of research and innovation via jointly agreed strategic research and innovation agendas. The Swedish platforms and SRA, and the Strategic Innovation Projects are good examples of practice. This should be done under competition, to ensure that they address areas where there is both opportunity and a viable set of partners willing to commit resources. This will entail, inter alia, the following:

  - *Develop innovation agendas which address relevant industrial challenges and needs.* These agendas will tackle the needs for R&D but also technology diffusion and more broadly the medium- to long-run innovation strategies. Involve end-users, regulators and other actors whose actions are necessary for success.

  - *Apply governance standards in line with good practices in PPPs (*road-mapping, accountability, clear commitments, ex-ante governance criteria, intellectual property rules, etc.), planning and periodical evaluation. This will also require stronger involvement of the government.

  - *Integrate SMEs including start-ups and foster linkages between start-ups and large firms*.

- *Maintain close monitoring and evaluation of the partnerships*. Ensure that project selection within the programme is done under competition and is quality assured by an external agency in order to ensure that the best possible work is done and to avoid capture of subsidy by the stakeholder group.

- *Encourage and facilitate new cross-sectoral collaborations with involvement of users, including public sector.* One example is the Challenge-driven Innovation Programme carried out by Vinnova in Sweden which has resulted in new, strategic, collaborations, e.g. between the mining industry and ICT companies.

· Re-establish funding for applied research and "enabling technologies" aiming at supporting innovation capacity to address both industrial and societal challenges.

- This will involve a combination of traditional Tekes-style technology programmes with wider programmes linking to the agendas attached to dealing with societal challenges. Some of the latter may be run by PPPs, provided due care is taken in designing their governance and in keeping them accountable to the government and society. Special care must be taken to close the "strategic research" gap.

· Use funding instruments to encourage de-fragmentation and strengthening of the research base, using centre-of-excellence arrangements in both academia-initiated and industrially-oriented research (and collaborative schemes).

· Increase the proportion of external research funding allocated via centre-of-excellence or competence-centre arrangements. These tend to de-fragment the research community and in the case of competence centres also to tune university activities towards areas of industrial and societal relevance.

· Attract foreign R&D location and joint initiatives with foreign firms through the creation of joint centres of excellence in key areas for future competitiveness and/or societal challenges (e.g. digitalization; big data, clean-tech and health-tech, etc.).

Kalewa SRA recommendations

Based on the identified priorities and assets as elaborated in the Kalewa SRA, to gain R&D and business breakthroughs with the Kalewa ecosystem, the recommended operational model and action portfolio should support initiatives following these recommendations:

Action recommendation #1: Establish strategic public-private partnerships (PPP). Addressing the PRAs successfully requires close strategic collaboration, spanning over several years and often beyond a single project, between industry partner(s) and SMEs, healthcare organisations and professionals, and research partners. The consortia need to be balanced in terms of type of organisations and competences, and have a strong commitment to collaborate towards a shared vision. Clear rules and model contracts and practices for data access, including a financial cost model and IPR are essential. Company-driven PPP projects must be ambitious and accountable for reaching the results, and success should be awarded, e.g., as next stage funding, e.g., as innovative public procurements.

Action recommendation #2: Focus R&D to leverage existing strengths. Actions should be focused and leverage existing spearhed competences and assets where globally significant competitive edge may be identified. Taking into account the rapid pace of development in AI, the PRAs should not be considered restrictive and they should be updated during the implementation of the SRA.

Action recommendation #3: Secure access to Key Assets. Actions must demonstrate timely and sufficiently wide access to the necessary data assets (quality & quantity) from the early phases of the project. Projects which take advantage of the unique health data assets should be prioritised. Consortia must include critical competences with world-class quality and critical mass in key areas, with will and experience in successful interdisciplinary collaboration, and strong commitment to the project and collaboration. Actions must specify how they ensure compliance with legal, privacy, regulatory and ethical requirements.

Action recommendation #4: Keep workplan agile with focus on well defined objectives. Project implementation should follow agile principles where objectives are well defined but workplan may be dynamically adapted when and if needed to reach the objectives.

Workplans should define final targets and vision, measurable milestones, and concrete KPIs, including plans for commercialisation and international dissemination. Detailed workplans should only be provided a maximum of one year at a time to avoid over-planning and fixation to tasks instead of goals.

Action recommendation #5. Invest on continuity. Funding should be committed for 3-5 years to ensure continuity and reduce overheads of forming the consortia and ramp up / ramp down costs, and to enable participation of different partners with different planning horizon. Progress should be reviewed at least annually, with possibility to budget re-allocation within consortium, including controlled changes in the consortium. Different funding instruments should be applied for different PRAs and/or different stages of the R&D. Sufficient academic research funding (e.g., via the Academy of Finland) is critical to maintain and improve competiveness of the domain in the long term. Coordinated funding via various instruments would increase impact, and participation of varying funding instruments, including private funding (e.g., VC funds) in later phases of the roadmap is desirable.

Action recommendation #6: Ensure scaling and adaptation to market, from local to global. Actions must support new innovations, products, and services targeting selected global markets in the long-term, or significant health and social care impact. Finnish infrastructure should be used as a launch pad towards selected target markets, and as a reference/spearhead implementation demonstrating the value of AI for Health applications. The regulatory environment and legislation in the target markets need to be included along the way towards the adaptation to these markets. Concrete international collaboration and dissemination must be on the roadmap. Real-life implementations with sufficient scale to validate solutions and evaluate their impact with convincing power should be targeted.

Proposed operational model for the Kalewa ecosystem

To address the observations and recommendations above with the contributions received during the open consultation with the Finnish Digital Health and Wellness actors, and discussions with experts having experience with the past SHOK instrument and various PPP activities at the European level, it was concluded that the most prominent operational model for the Kalewa ecosystem purposes would be based on the Turku Rolls-Royce Center of Excellence model,

which is based on an industry-driven consortium. However, the specificities of the Kalewa SRA focus on health and wellness entails a key role for the public sector actors which must be reflected in the Kalewa operational model.

In this proposed model (Figure 46), the coordination and support action responsibility is assumed by the Kalewa PPP LE (Legal Entity) which is responsible for the overall coordination for the R&I activities executed under the Kalewa programme by the Kalewa PPP core partners. The Kalewa PPP LE is formed by core partners representing the key actors of the Finnish Digital Health and Wellness ecosystem. The main responsibilities for the Kalewa PPP LE include the coordination of projects to apply for the Kalewa Programme run by Tekes, to act as the single point of contact for ecosystem actors to disseminate information about the activities within the project pool, data owners, infrastructure and PoC/pilot activities. Similarly, Kalewa PPP LE will act as the representative in regulative and legislative issues concerning the needs for the project pool and overall awareness raising of the Kalewa PPP activities.

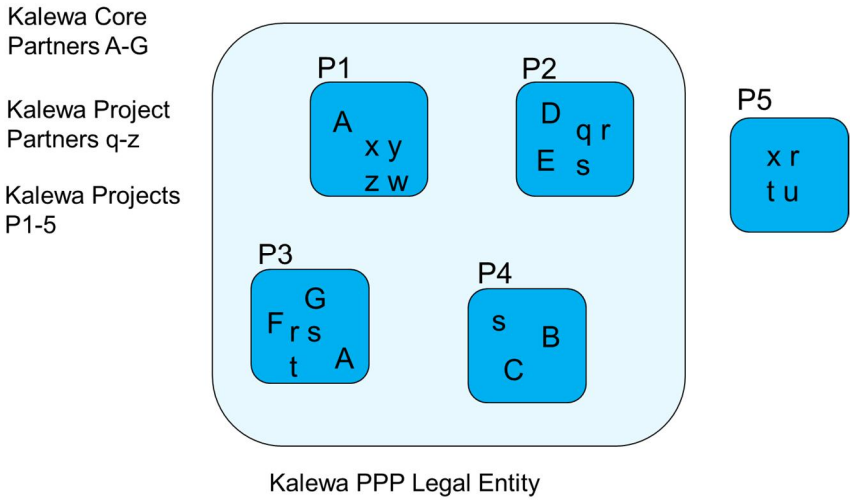


Figure 46: Kalewa PPP operational model.

It should be noted that the detailed responsibilities of the Kalewa PPP LE will depend on the actual core partners participating and

should not be prescriptively set in a top-down manner. A practical example would be the potential presence of the ISAACUS or biobank data operator, which could have an important role as a member responsible for data and infrastructure actions. Further, it should be noted that it is desirable to have Kalewa programme projects which are not participated in by any of the core partners as part of the PPP projects (i.e. standard Tekes funded projects within the Kalewa Tekes Programme): this will have a positive impact in terms of the attractiveness to the ecosystem and its evolution. Naturally, the ecosystem can attract funding from other sources as well (Figure 47: for example Academy of Finland, H2020 & other EU instruments).

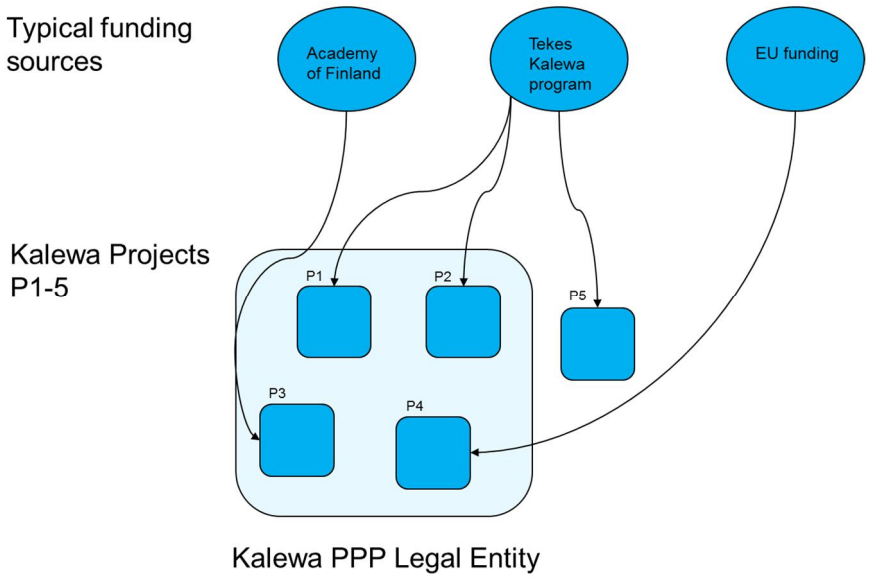


Figure 47: Kalewa PPP activities funding sources.

3.4 Main building blocks

3.4.1 Priority application areas for AI for Health

In the following, the Priority Research Areas (PRA) where the most benefits are foreseen with the use of AI for health and wellness are

described. All PRA activities should target developing new innovations, products and/or services and utilize and elaborate the Key Assets (Chapter 3.4.2 and Figure 48). Each PRA is assessed in terms of:

- Data - does the Finnish ecosystem provide access to unique data assets, which might generate unique competitive advantages in a global perspective?
- Competences - are necessary competences to address the PRA challenges available in the ecosystem, both in terms of quality (world class competence) and in sufficient critical mass, including potential industrial partners to exploit the results commercially.
- Impact - what would be the impact on *health and social care or wellness services* in case of success, especially in terms of health outcomes and/or productivity?
- Global market potential - what is the commercial exploitation potential of the results for global markets?

Potential impact on social and healthcare is differentiated from global market potential as the latter may often be reached by very focused, even niche, products and services, which may have an impact on the health outcomes of a limited number of individuals (e.g., care of rare illnesses) and are not sensitively dependent on national infrastructures and practices, while the former calls for addressing issues which constitute a significant fraction of the social and healthcare costs or productivity-related factors. Both forms of impact are addressable by the SRA as a whole, but through different actions.

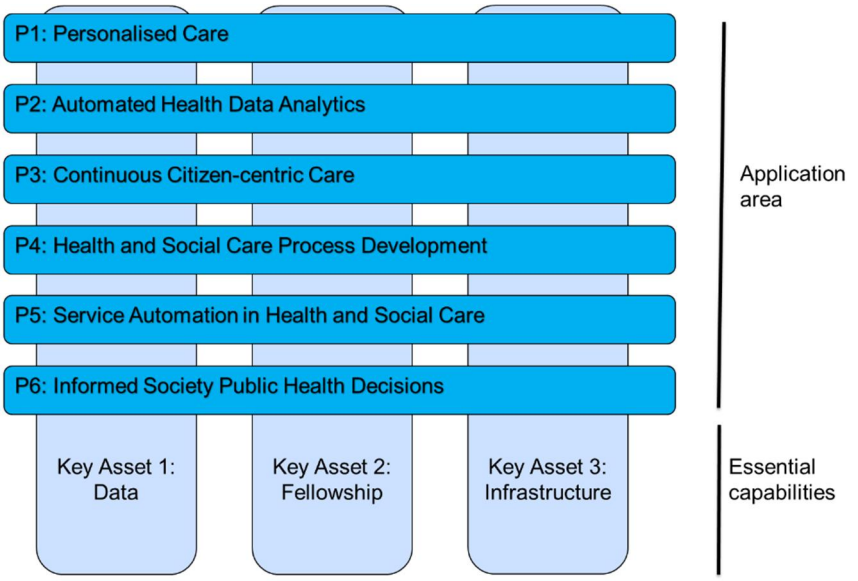


Figure 48: Priority Research Areas and Key Assets in AI for Health SRA.

PRA #1: Personalized care[16]**:** Personalized medicine applies especially genetics and genomics to match patients and treatments and has been suggested as the next major revolution in healthcare[17]. Personalized care, as a broader platform, includes genetics and genomics but also includes any other information that helps predict risk for disease or how a patient will respond to treatments. This PRA refers to procedures where healthcare treatments are designed specifically to match the unique characteristics of individuals. Relevant data may include (but is not limited to) genomic and other 'omics data as well as other health and behavioural data including data from sensors. AI is a vital component in personalized medicine to analyse massive amounts of data, e.g. to identify similarities between prospective individuals and the datasets of past individuals (e.g. biobanks) to identify the most promising individualized treatments. Activities in this PRA include: development of methods for patient profiling (incl. in-silico models), diagnostics and/or personalized treatment selection based on large amounts of data from individuals as well as peer cohorts; data-driven exploration and modelling of disease mechanisms and progression models; real-life implementation,

[16] https://health.clevelandclinic.org/2012/05/what-is-personalized-healthcare/
[17] http://www.nature.com/nrclinonc/journal/v8/n3/full/nrclinonc.2010.227.html

validation and evaluation of personalized care applications. The primary target is to improve health outcomes of individuals by timely and personally optimal interventions, either preventative or curative.

#1: Personalized care	Data: Unique data assets, especially quality, longitudinity and ability to combine data from different registries on individual level Competence: World-class medical research, big data analytics and AI, some spearhead companies Impact: Potentially significant impact on health outcomes on individual patients Global market potential: Significant global market potential, solutions often exploitable / scalable in global markets with reasonable effort

PRA #2: Automated health data analytics: Challenges in data-driven health and social care are transferring from acquisition and providing access to data into its interpretation with an affordable amount of human labour. Automated analysis and curation of complex health data – from biological to imaging, electronic health record, and sensor data – require expert knowledge, skill and manual labour for reliable quantification and interpretation. AI can automate the pre-processing, analysis and interpretation of such data. Examples of automated tasks include manual segmentation of medical images, annotations of long-term recordings of biomedical signals, analysis of long-term wearable sensor data (e.g. multimodal monitoring of patients and elderly at home with unobtrusive sensors, or 24/7 monitoring of activity and beat-to-beat heart rate of the employees for stress and recovery analysis). With the development of IoT technology and wearable sensors, the challenges of applications in health and wellness are transforming from acquisition of the data into its interpretation with affordable amount of human labour. This PRA calls for activities to develop and validate AI-based methods to automate the quantification and interpretation or classification of complex, multimodal health and wellness data, with applications ranging from critical care to consumer wellness. The applications should demonstrate improved cost-effectiveness while improving (or at least maintaining) the quality of care.

#2: Automated health data analytics	Data: Significant and sometimes unique data assets, including imaging, wearable sensor data, physiological databases. Competence: World-class biosignal and image processing, data analytics and AI, several spearhead companies

	Impact: Potential high impact on health outcomes and on healthcare productivity Global market potential: Significant global market potential, results often exploitable to global markets

PRA #3: Continuous citizen-centric care: Prevention and management of chronic conditions require continuous, predictive, personalized and participatory actions, including lifestyle support / counselling. In this approach, the citizen is the key co-producer of health. This PRA includes actions to improve continuous proactive and preventive management of health and well-being of individuals by automatically monitoring and integrating information from various sources and utilizing AI to provide intelligent analysis and interpretation of the current health status as well as forecasting its progress. Activities may contribute to AI-based coaching to improve engagement, adherence and motivation of the individuals towards healthier lifestyle in community settings, with minimal professional participation; and real-life implementation, validation and evaluation of AI-based health and wellness management applications. Applications may range from elderly care to chronic disease management or prevention, and to improvement of well-being and performance in healthy individuals (e.g. sports, corporate wellness). A specific challenge is to develop AI solutions able to engage people in maintaining and / or improving their health.

#3: Continuous citizen-centric care	Data: Unique data assets, especially quality, longitudinity and ability to combine data from different registries on individual level (both health and social care, and wellness data) Competence: World-class medical research, data analytics and AI, some spearhead companies Impact: Potentially significant impact on health outcomes of individual patients and healthcare transformation to P4 approach Global market potential: Significant global market potential, results often exploitable to global markets

PRA #4: Health and social care process development: Effective and efficient health and social care aims to provide the *right actions at the right time on the right patients/clients.* This PRA applies AI to improve productivity, i.e. *value produced per euro spent*, in health and social care as well as wellness services. Activities include AI- and data-driven intelligent forecasting of resource needs, optimal

and predictive care path planning, predictive outcome analysis, and intelligent scheduling and resource organization. Activities should target productivity leap (in health and social care or wellness service provision based on more efficient use of resources, improved outcomes, improved throughput rates and/or reduced waste of efforts. Utilized data includes typically organizational and/or population (cohort)-based data but may also include individual level data.

#4: Health and social care process development	Data: A lot of data available, uniqueness in combination of different data sources. Competence: Data analytics and process optimization for mainly domestic applications in some institutions and companies. Impact: Potentially very significant impact on health and social care productivity Global market potential: Solutions often local, not easy to globalize.

PRA #5: Service automation in health and social care: AI can enable new ways to deliver health and social care as well as improve productivity by reducing the need for routine human intervention and customer interaction, freeing personnel time to focus on the most value-adding care activities. This PRA focuses on applications of service automation in health and social care. Activities include: application of chat bots (e.g. counselling, time booking, information enquiry, triage), development of AI-based user interaction for health and social care systems, automated transformation of information between different systems, and NLP (Natural Language Processing) applications. An essential component of the automated processes enabled by the AI is the accurate identification of situations where human communication is required instead of AI (e.g. identification of life-threatening conditions). Activities should target disruptive products and services, which utilize AI and demonstrate improved productivity, improved access to care and/or reduced wait times, better client satisfaction, and improved accuracy of management of unstructured information (esp. text, speech).

#5: Service automation in health and social care	Data: A lot of data available, but no national unique assets. Competence: Some academic research + SMEs specialized in the processing of Finnish and Swedish languages. Impact: Potentially very significant impact on health and social care productivity

	Global market potential: Solutions often language- and culture-specific, global market reach challenging / limited

PRA #6: Informed society public health decisions: The impact of health-related policy decisions on society are difficult to predict and require complex modelling of the entire system (society). Single actions, such as changing the taxation of alcohol or reducing the reimbursement rate of prescription medication, may have effects that are caused through complex networks of causal changes. The target of this PRA is to improve health and social well-being-related decision making on individual, organizational, and societal levels via systematic and intensive use of data. Big data analytics and AI can help in planning the optimal population-level strategies, e.g. for disease screening and other public health campaigns.

#6: Informed society public health decisions	Data: A lot of data available, uniqueness in combination of different data sources (nationwide registries) Competence: Competencies in healthcare and health economics research and big data analytics, very limited number of companies Impact: Potentially significant impact on health and social care productivity, health outcomes and public policy in the long term Global market potential: Very limited commercial exploitation potential but may help in building Cape Health brand

The following Table 2 summarizes the different priority areas in terms of their assets in data and competence and in their potential for health and social care impact and successful global market exploitation.

Priority Research Area	Access to unique data	World-class competence	Healthcare impact	Global market potential
#1: Personalized care	+++	+++	++	+++
#2: Automated health data analytics	+++	+++	+	+++
#3: Continuous citizen-centric care	+++	+++	++	+++

#4: Health and social care process development	++	+	+++	+
#5: Service automation in health and social care		+	+++	+
#6: Informed society public health decisions	+	++	++	

Rating	
+++	significant competitive edge or potential impact
++	moderate competive edge or potential impact
+	some competitive edge or potential impact

Table 2: Priority Area assets and potential impact.

The AI for health PRAs presented above vary significantly in terms of their potential healthcare impact on one hand, and global market potential on the other:

- PRA #1–3 leverage Finnish health data repositories and technology competences, have strong support within existing Finnish industrial players, and significant commercial potential globally in case of successful development and validation. The client for the resulting products and services is typically either a healthcare professional or in some cases an individual citizen and the impact on health outcomes and/or treatment or management of specific diseases may be significant. These PRAs may be supported, e.g. by innovation funding and investments in technology development, testing, validation (evaluation) and exploitation.
- PRA #4–6 address areas with significant health and social care spending and focus on applications of AI for improving health and social care and wellness service productivity; hence their impact on healthcare costs and/or health outcomes may be very significant. The client of the resulting services is often a health and social care provider. These PRAs are strongly driven by healthcare cost crisis and health and social care reform, and resulting products and services often have strong dependencies

on cultural and national factors such as language, reimbursement policies, and overall health data infrastructure implementation. The development of these innovation areas may be supported by innovation funding but also by innovative procurement practices and close public-private partnerships in development and early use of novel solutions.

3.4.2 Key assets for AI for Health

Key Assets are cross cutting requirements to successfully implement the R&D in each of the priority research areas listed in Chapter 3.4.1. They are existing properties of the Finnish ecosystem that can give significant competitive edge to the solutions to be developed. **Each activity implementing the SRA should address these Key Assets**.

Key asset #1: Data. The most significant Key Asset in Finland for AI for Health is the strength and uniqueness of the Finnish data repositories – especially their coverage, longitude, quality (but not size), and ability to link different data sources on individual levels. Quality of AI solutions is sensitively dependent on the quality and representativeness of the data and hence efficient utilization of this Key Asset should be the main driver of the AI for Health SRA. Access to high-quality, longitudinal, large-scale multidimensional and multimodal biological, healthcare, and/or wellness (consumer-generated) data and possibility to use it for research and development should be ensured on a large scale to develop breakthrough AI-based innovations. This is especially important in Priority Research Areas focusing on improving prevention, prediction, diagnosis, and care of the patients. Also, novel combinations of health data and other related data sources such as environmental monitoring, transportation, use of public services, and social media have the potential to become a key enabler of R&D breakthroughs. While access to valuable data repositories requires ethical and organizational approvals and patient consent, the activities intending to make use of such data repositories should provide a clear data access and management plan as a part of their project plans. The SRA activities should optimally support national initiatives to foster centralized data management (e.g. national biobank operator initiative), but should not be designed to be dependent on their timely implementation, but rather

ensure their access to critical data assets from early stages of the projects.

Key Asset #2: Fellowship. True and strategic, long-lasting fellowship between key stakeholders in healthcare, academia and business is one of key strengths of the current Finnish health technology ecosystem. This fellowship can foster innovative co-creation of future breakthroughs. Finland has high-level competences (education + research) in all key areas of the AI for Health research agenda, with some clear spearheads, as well as strong core industry ecosystem with some spearhead companies and a strong SME cluster. Most importantly, Finland has a strong culture of public-private, as well as medicine-engineering collaboration. This Finnish ecosystem with this spread of skills, experience in winning in global markets, and with commitment and ability to collaborate towards shared goals is a Key Asset, which the AI for Health SRA should further enforce and harvest. Activities should engage balanced consortia with a critical skillset and strong commitment to collaborate. Activities should engage with expertise in understanding legal, regulatory and other requirements in order to fulfil all the needed medical device and other applicable requirements on time to smoothen transforming results into global business. Creating business models on top of these solutions will require understanding the value network of social and healthcare services and the changing data driven relations between regulators, payers, public providers, market providers, technology providers and individuals.

Key asset #3: Infrastructure. Finland has a forward-looking and novel legal and operative health information infrastructure with a wide coverage of electronic health records, a modern biobank act, act on secondary use of health information[18], a universal national identification number for citizens, and a long tradition in public funding for public-private, industry-academia, and biomedical engineering partnerships. In addition, there is a plan to create nation-wide access system to health data repositories (incl. biobanks) in the coming years (e.g. ISAACUS, biobanks). All this will offer unique opportunities for development and validating AI-enabled data-driven health and wellness services. However, it should be recognized that the current infrastructure is by no means complete and ready to optimally support AI for Health SRA. **Further significant strategic investments are required to implement the national health data**

[18] In progress, to be approved during 2017

infrastructure, including interfaces, consent management, etc. Furthermore, to scale actions towards global dissemination and exploitation, it is necessary to analyse and take into account relevant international legal and regulatory frameworks, data sharing principles, data privacy and security, and ethical and societal issues. Activities should further leverage the Finnish ecosystem, infrastructure and its capabilities, contribute to enhancing the data infrastructure, and facilitate attracting further investments (both public and private) to the Finnish AI for Health innovation hub and related facilities.

Research and Innovation actions

The six priority areas as identified in Section 3.4.1 form the core application areas for the Kalewa Research and Innovation activities. In addition, developing and maintaining the key assets #1 (Data) and #3 (Infrastructure) include R&I activities in addition to actions related to PoCs and trials.

Coordination activities

To create an operational model which can sustain a long-term strategic partnership of core partners for a minimum of five years, the activities should be coordinated by a private sector legal entity as recommended in Section 3.3. The main responsibilities for the Kalewa PPP LE include the coordination of projects to apply for the Kalewa Programme run by Tekes, to act as the single point of contact for ecosystem actors to disseminate information about the activities within the project pool, data owners, infrastructure and PoC/pilot activities. Similarly, Kalewa PPP LE will act as the representative in regulative and legislative issues concerning the needs for the project pool and overall awareness raising of the Kalewa PPP activities.

Infrastructure

Activities to build a national technical infrastructure to enable wide access to key health data repositories. Depending on the composition of the Kalewa PPP core partners, the role of this category of activities can vary from an active role in the development of the infrastructure to the coordinated liaison with the health data operator. However, it should be noted that it is essential for the evolution of the Kalewa ecosystem that access to data and open interfaces are

provided to catalyse new, innovative services and products beyond the initial constellation and activities of the Kalewa PPP.

Proof of Concepts – Trial Activities

This is the support action to coordinate piloting environments with the larger stakeholder groups to test, develop and validate new products and services. Similar to infrastructure, this category of activities is an essential part of the innovation phase of the Kalewa actions. Access to PoCs and trial environments are essential, especially for smaller companies to further the business creation and evolution of the Kalewa ecosystem.

3.5 Partners and their roles

A typical strategic PPP is based on the leading role of at least 3–4 key industrial actors in the strategically defined thematic area: in the particular case of health, care and wellness, the role of public sector actors is essential for the proper functioning of the Kalewa PPP.

Core partners are the key stakeholders creating the Kalewa PPP LE: they are the driving forces of the Finnish Digital Health and Wellness ecosystem representing the majority of business and IPR creation in Finland. Key public sector actors should be represented among the core partners to ensure sufficient steering from the 'customer' side of stakeholders representing the active R&D actors in the public sector. However, the emphasis should be on the industry lead category of partners to ensure sufficient focus on new business creation by the Kalewa ecosystem. Key partners are expected to lead the strategic project activities and invest significantly into the Kalewa PPP projects. The group of core partners is created with the lead of the Kalewa PPP coordinating actor.

Project partners complement the role of the core partners in the Kalewa PPP projects by providing skills and competences to co-operate for the individual goals of the projects in addition to their financial contribution, data or resources.

Infrastructure operator(s) are essential for providing access to numerous health or biobank data sources through open interfaces. For many of the priority activities as defined in the Kalewa SRA, access to data is essential and a key competitive factor for the Finnish ecosystem to lead R&I activities on closely focused areas.

Pilot environment operator(s) are either Kalewa PPP project partners or independent actors interested in providing an environment for PoC or trial purposes for the Kalewa PPP projects.

Public sector funding organizations will provide partial funding for the Kalewa PPP projects according to the strategic goals set for their specific funding instruments. For the purpose of the operational model of the Kalewa PPP, the main public funding source is Tekes. Other foreseen sources are the Academy of Finland, EU funding sources (esp. under H2020 umbrella), Sitra and THL.

3.6 Cost structure

The cost structure of the Kalewa PPP can be divided into the following main categories following the proposed operational model:

1. Coordination activities

   To create an operational model able to sustain a long-term strategic partnership of core partners for a minimum of five years, the activities should be coordinated by a private legal entity (company, association or foundation). The members of this legal entity are the core members representing the main private actors of the Finnish industry with potentially some of the public sector actors. This category of activities should be funded in the proportion of 50:50 by the core members and Tekes. The core members are expected to invest heavily in the coordination activities, especially if the infrastructure and pilot activities are to be partially covered by the Kalewa PPP LE. Naturally, this requires that the majority of the Kalewa PPP projects rely largely on data, infrastructure and pilots by common actors, otherwise it makes more sense to handle these aspects on a per project basis. The administrative nature of coordination activities should be kept lean and efficient.

   The main responsibilities for the Kalewa PPP LE include the coordination of projects to apply for the Kalewa Programme run by Tekes, to act as the single point of contact for ecosystem actors to disseminate information about the activities within the project pool, data owners, infrastructure and PoC/pilot activities. Similarly, Kalewa PPP LE will act as the representative in regulative and legislative issues concerning

the needs for the project pool and overall awareness raising of the Kalewa PPP activities.

2. Research and innovation actions

   The bulk of the Kalewa ecosystem activities falls under this category: research and innovation activities targeting for new product and service creation take place under this category. The funding for this category of activities could be organized on the Tekes side as a Kalewa programme, which would be open for applications coordinated by the Kalewa PPP with an earmarked proportion of the overall programme budget. This category will include also activities related to the infrastructure and pilot environments according to the general funding principles of Tekes.

3.7 Funding structure

The three most significant funding bodies of competitive public R&I funding in Finland are Tekes, Academy of Finland, and the EU commission through the Horizon 2020 framework programme. However, it should be noted that the EU Horizon 2020 funds only 3 % of the research in Finland. This highlights the importance of national funding instruments in Finnish publicly funded R&I. The applicable funding sources depends on the nature of the Kalewa PPP projects which is especially important for the EU funding sources: eligible activities and maximum funding rates can typically vary from 25% to 100%.

Clearly, for the Kalewa PPP projects, the main public funding source is Tekes that is proposed to fund the coordination and support actions in addition to project funding through a Tekes programme. It is foreseen that some of the activities clearly fall under the interest of Sitra (ISAACUS) and activities closer to strategic research to the funding instruments of the Academy of Finland.

In the EU funding context, H2020 has many instruments that can be seen as feasible despite the rather long process and low success rates in many of the calls. Naturally, other EU funding sources can be identified, for example EIT Health, EIT Digital and ECSEL JU has a specific action line for health in addition to Eureka to mention a few. Additionally, the EU has funding instruments geared towards capability and research infrastructure building activities where there

might be potential in specific cases for Finnish activities to qualify for these instruments.

Naturally, partners are expected to cover a substantial proportion of the Kalewa PPP project activities in the form or funding or in-kind contributions in accordance with the specific rules for each funding instrument used.

One form of funding is venture capital, but this is difficult to include in the actual funding structure as this is typically targeted for individual partner organizations rather than to the Kalewa PPP project activities. Naturally, the capability to attract VC funding for the Kalewa PPP partners based on the results from the Kalewa projects would be an excellent performance indicator.

3.8 Kick-off tasks & responsibilities

There are three main phases involved on the creation of the Kalewa PPP operational model. First, a coordinator for the creation of the Kalewa PPP LE needs to be nominated, secondly the Kalewa PPP LE needs to be created and thirdly the actual Kalewa Programme needs to be created.

1st phase:

- Call for the coordination and support action (CSA) coordinator (call, evaluation, nomination) (responsible: Tekes)

2nd phase:

- Creation of the core partner consortium (responsible: CSA nominee)
- Creation of the legal entity of the CSA coordinator (responsible: CSA nominee)
- Definition of the governance model for the Kalewa programme (responsibilities: Tekes+CSA nominee)

3rd phase:

- Kalewa R&I Tekes programme definition and call (definition, call, evaluation, nomination) (responsible: Tekes)

Kalewa Tekes programme execution:

- Project consortium building and project proposal submission to Kalewa programme (responsible: consortiums)

Phases 1 & 3 can be performed partially simultaneously. The 2nd phase can potentially take a rather long time (up to one year) and should be taken into account when deciding the timing for the launch of the potential relevant Tekes programme.

3.9 Kalewa programme/project portfolio type/overview for the 2018-2021

The Kalewa Tekes programme portfolio should be based on the priorities and key asset areas as described in sections 3.4.1 and 3.4.2 following the outcome of the consultations with the Finnish Digital Health and Wellness stakeholders supporting activities in the categories as defined in Section 3.6.

3.10 Data sources

Finland has extensive national registries, survey datasets and related health and welfare statistics. The main dataset holders are the National Institute for Health and Welfare (THL), Statistics Finland, Kela (national social insurance institution) and ETK (Finnish centre for pensions). THL holds the national primary care and hospital discharge registers, birth and related child health registers, national cancer register and several other special registers. THL also holds extensive population survey and clinical study datasets, which are routinely combined with administrative register data for research purposes. Statistics Finland holds the causes of death register and socio-economic population datasets. Kela has data on social benefits and drug reimbursements and ETK on pensions.

Currently, there are eight registered biobanks in Finland, with two nationwide biobanks (THL biobank with population cohorts and a FHRB Biobank focused on haematology) and six clinical biobanks run by universities and hospital districts. Large Finnish population cohort studies have long had a major focus on genomics research

and currently the THL biobank includes samples and data from 126 000 study participants with DNA from 70 000 participants. Further transfer of existing collections to the biobank during 2017–18 will include up to 100 000 study participants, and three new population cohort collections are underway with an objective to collect up to 35 000 new samples by 2018. HUS biobank, in turn, has currently 1.4M samples. Finland has recently decided to invest in the creation of a national genome centre and a national cancer centre, and in the coming years the coverage of the biobank and genome data will rapidly increase. The Finnish biobanking activity and co-operation will be boosted to the next level with the proposed founding of a national biobank operator which aims to create common data management and sharing infrastructure to facilitate utilization of biobank data.

The unique strength of the Finnish health datasets lies in the opportunities to link the collected samples with sample-associated data from other data archives: medical history, health status, nutrition, exercise, smoking, alcohol consumption, sleep, clinical examinations, laboratory measurements, omics data and follow-up data from national health registers. Current research questions in population cohort studies are linked to genotype data combined with a patient record and health registry data. This can provide insight into how genetic variation can influence the onset, prevention and treatment of diseases and how this information may be used to develop new therapeutics.

The issue with integrating data from various current social welfare and healthcare information systems is poor compatibility and interfacing between the systems in use. Additionally, the data privacy legislation has affected the present state of information systems. Health and social care information system architecture has approximately 400…800 systems, with more than 500 connections between them, about 10 000 expert users and 10–100 system owners. The integration of data from this setting remains a challenge to be solved in order to unleash the full potential of Finnish health data. Essential to the reform of the information systems is establishing uniform data with consistent building of systems. In addition, focus needs to be given to the systems specification, open interfaces between different systems as well as on general transparency and usability of infor-

mation. The generating of uniform data also requires a unified understanding of data content and data classification that are commonly agreed upon. [19]

3.11 Impact of regulations

As all documentation of patient data in Finland is digitalized and as the same will soon apply also to data on social services, there are versatile opportunities for the secondary uses of health and social care information. Secondary uses mean *all other handling and analysis of sensitive patient / customer data than what is needed for treatment, care and services received by the individual him/herself*. Secondary uses include, e.g. generation of statistics and indicators, research and product/service development, service operations management and planning, supervision and service system monitoring/surveillance. The potential of secondary uses in Finland is especially high, since data from different administrative and EPR sources can efficiently be linked with unique identifiers (personal ID, organizational ID, service events/instances, geographic coordinates, etc.).

The legislative framework in Finland for secondary uses is currently under renewal. The main objectives of the new legislation are 1) to align the national regulations to the European General Data Protection Regulation (GDPR), which enters into force in spring 2018; 2) to broaden the possible secondary use cases of health and social welfare data; 3) to enable the use of Kanta Data Archives as sources of data for secondary uses 4) to remove administrative bottlenecks and unnecessary bureaucracy and to create centralized services for accessing national health and social welfare data resources. The legislation is planned to enter into force in the beginning of 2018 and respective national services are currently under development in collaborative projects between THL, Statistics Finland, Social Sciences Data Archive, National Archives of Finland and major Hospital Districts.

The Finnish biobank Act (2013) provides a globally unique framework for versatile basic and clinical research on data extracted from human biological samples and combined with other data. The Biobank Act's explicit objectives include the support of research that utilizes human biological samples to promote openness in the use of

[19] Petri Virtanen, Jari Smedberg, Pirkko Nykänen ja Jari Stenvall, Palvelu- ja asiakastietojärjestelmien integraation vaikutukset sosiaali- ja terveyspalveluissa, Valtioneuvoston selvitys ja tutkimustoiminnan julkaisusarja 2/2017, 10.1.2017

samples and data, and to secure the protection of privacy and self-determination when processing samples and data. The Act applies to both public and private biobank entities, and covers clinical, population, and research-based biobanks.

The Biobank Act defines how biobanks are registered, how a broad "biobank consent" can be given by participants and how the rights of participants are protected. Transfer of existing sample and data collections to biobanks has been widely implemented and can be done with an opt-out procedure. Collection of new biobank samples is possible in routine hospital processes as well as in population cohort or clinical studies. The biobank act allows the possibility to recontact consented donors/participants and enables research collaboration with industry. The possibility to collect samples and data from healthcare is complemented with possibilities to link biobank samples with hospital data (EMR) and data from national registries (hospital discharges and procedures, outpatient visits and procedures, causes of death, pharmaceutical purchases and reimbursements).

The gold standard method for proving effectiveness of any treatment or medicinal product is a randomized, blinded study design. The new EU regulation of clinical trials on medicinal products expected to come into force in 2018 is anticipated to facilitate the conduct of cluster-randomized trials, by allowing studies with simplified informed consent process in phase IV studies of licensed medicinal products. This change in the EU regulation, combined with the comprehensive access to routinely accumulating nationwide digital health data in Finland, provide unique opportunities to conduct nationwide comparative studies, and to measure the public health impact on all levels of healthcare, starting from self-medication/primary care use, and ending at hospitalizations or even fatalities. The ability to conduct top-quality comparative trials – with a considerably lower cost – has potential to develop into an established public-private collaboration infrastructure, also with major public health benefits through more effective healthcare. The new EU regulation limits the application to medicinal products, but similar processes should be adopted to be allowed in studies of any established treatments or other methods of health management.

3.12 Collaboration with national and international networks and accelerators

The Kalewa ecosystem cannot be an isolated actor within the larger context of health, care and wellness nationally or internationally. Numerous organizations and networks are active with different foci and levels of maturity which can play an important role for the overall activities of the Kalewa PPP. Nationally, some of these are potential core partners or at least key partners to co-operate on building the necessary enablers for the successful execution of Kalewa activities. Some of those with the most potential are mentioned here. For a more comprehensive list and analysis, please refer to the Task 2 report of the Finnish Digital Health and Wellness industry actors.

SalWe is a *platform for cooperation between companies, universities, research institutions and healthcare professionals*. Its activities foster the international business operations of the health and well-being sector, and its social impact. SalWe produces research-based data that creates a competitive advantage for companies in developing products, services and practices. The focus is on maintaining and improving individual functioning. SalWe seeks to prevent, detect and treat diseases with serious social impacts, such as brain dysfunction, injury and stress, lifestyle diseases, microbial infections and inflammation, and certain cancers. The common feature of SalWe's activities is individually tailored monitoring and management of health, well-being and lifestyles. SalWe Ltd. has 33 shareholders, 19 of them companies and 14 research organizations. It was established in 2009 and, in the same year, was officially designated as a Strategic Centre for Science, Technology and Innovation in Health and Well-being.

Healthtech Finland is an industry association and part of Technology Industries of Finland. Healthtech Finland is also a community, fostering our industry's growth and collective knowledge. Healthtech Finland members (nearly 100) cover the health technology sector widely including: diagnostics, laboratory solutions, monitoring, imaging, ehealth, artificial intelligence, telemedicine, care, rehab, hygiene, furnishing, logistics and services.

EIT Health is one of the largest healthcare initiatives worldwide. Its goal is to sustainably advance the foundations of healthcare and thus promote the future conditions for healthier living and well-being of people across Europe. EIT Health is leveraging the expertise of

more than 130 leading organizations spanning key areas of healthcare such as Pharma, MedTech, Payers, Research Institutions and Universities. Chosen by the European Institute of Innovation and Technology (EIT) to form EIT Health, the consortium offers best-in-class research capabilities, higher education and business expertise. With a budget of 2 billion EUR over the next decade, it will purposefully invest in Europe's best entrepreneurial talents and creative minds to foster the development and commercialization of smart product and service solutions in the health sector, addressing the challenges imposed by demographic change and ageing societies. Currently, there is no EIT Health co-location centre in Finland (the closest is in Sweden): with a sufficiently wide portfolio of activities and partners, Kalewa PPP could seek partnership with EIT Health and create a co-location centre in Finland. EIT Health funds partially the activities of its partners under the H2020 framework programme.

Additionally, there are numerous actors in the field of health and wellness facilitating ecosystems with a regional or national interest. Typically, the regional activities are focusing on specific topics based on the local expertise and specialization (for example Tampere Health Hub, OuluHealth, Oulu Centre for Health and Technology, Health Campus Turku, HealthSpa) or networking on national basis (Finnish health innovation and testbeds). Further, industry driven ecosystems are increasingly emerging, such as GE Health Innovation Village and IBM Watson Health Center as an example. A public actor can be in a leading role as is in the case of CleverHealth network.

3.13 Global research collaboration

One of the recommendations in [15] states the following:

- Attract foreign R&D location and joint initiatives with foreign firms through the creation of joint centres of excellence in key areas for future competitiveness and/or societal challenges (e.g. digitalization; big data, clean-tech and health-tech, etc.).

For example, Tekes and IBM already have concluded a MoU in 2016 to co-operate within the area of AI in health. Depending on the boundary conditions for the research co-operation with IBM, this might be an opportunity to accelerate Finnish business creation in specific, narrow areas. However, the funding mechanisms in place might not be able to address the specificities to facilitate this and a

different approach would need to be put in place. Also, the expected impact in terms of value for money and business creation should be carefully assessed for such an investment.

Past examples have demonstrated that talented resources, access to infrastructure and open interfaces are of key importance in attracting global research presence or collaboration with Finnish companies. Kalewa activities clearly has the potential to create first-class results in specific areas of application and hence contribute to the attractiveness of the Finnish ecosystem on a global basis.

3.14 GoTo Market Support

Depending on the specific needs of the Kalewa PPP partners, it should be evaluated if dedicated actions are required for GoTo market Support beyond the currently available services by Team Finland.

3.15 Conclusions and summary

The public open consultation with the Finnish Health and Wellness ecosystem actors combined with recommendations and best practices to revise the Finnish innovation system give clear guidance to build an operational model for the Kalewa ecosystem. The proposal relies on the strategic PPP model where key industrial actors are in the driver's seat to define the strategic priorities for the R&I activities to be carried out in the Kalewa Tekes Programme. The importance of the public sector actors is duly recognized and their participation in the Kalewa PPP is essential to ensure proper inclusion of the views from the customer side of the health, care and wellness ecosystem in Finland.

The Kalewa PPP programme is focused on six priority areas, as identified in the Kalewa SRA: Personalized care, Automated health data analytics, Continuous citizen-centric care, Health and social care process development, Service automation in health and social care, Informed society public health decisions. These are supported by the three key assets of the Finnish ecosystem: Data, Fellowship and Infrastructure.

Appendixes

APP. A Municipal healthcare cluster

The healthcare *customer cluster* includes the focal municipal organizations, large hospital districts and smaller local health centres, run by public organizations. Also, all municipal stakeholders, such as buying organizations, play important roles in this cluster.

Municipal health centres provide *primary health services*, run by **160 local health centres**. Primary health services include (http//stm.fi/terveyskeskukset) wards for patients requiring nursing care, health counselling, health education, contraception advice, maternity and child welfare and medical examinations, screening and vaccinations, oral health services, school and student healthcare, mental health services, emergency treatment and home care services.

Hospital districts provide *specialized medical care services*, run by 20 hospital districts. The largest of them is the **Hospital District of Helsinki and Uusimaa, HUS**. HUS is a joint municipal healthcare organization formed by 24 municipalities. HUS provides specialized medical care services in all major fields of medicine and employs over 22,000 healthcare professionals. HUS aims to offer patients in all member municipalities timely and equal access to specialized medical care (Picture 2). One future theme is artificial intelligence. HUS runs the Virtuaalisairaala 2.0 project, which aims to make use of AI (http://events.almatalent.fi/tekoaly/puhujat/. Each hospital district has a central hospital and other hospitals.

Figure 49: HUS hospitals and specialty care service categories

University hospitals provide *highly specialized medical care*. University hospitals are located in Helsinki/**HYKS**, Turku/T**YKS**, Oulu/**OYS**, Tampere/**TAYS** and Kuopio/ **KYS**.

Health Capital Helsinki is a *hub of life science and health tech research*, knowledge and business. Key focus areas are neuro, cancer, digital health, future hospital, food, sustainability, and biodiversity. Health Capital Helsinki alliance members are The City of Helsinki, the University of Helsinki, Aalto University and HUS Helsinki University Hospital, which are developing a research-based *innovation and business ecosystem*, with the aim of making Helsinki the leading European region of life science and health tech.

BusinessOulu *supports growing companies* in creating jobs, promoting export, refining competencies and developing different lines of business. BusinessOulu supports innovative entrepreneurship, cooperates with international, local and national partners and has a multidisciplinary focus: ICT, Life Science, Cleantech, Industry, Trade & Services, Travel & Logistics and Creative Industries.

Association of Finnish Local and Regional Authorities (in Finnish Kuntaliitto) *promotes local self-government and the modernization of municipal services*. Its aim is for Finland to be recognized as a locally and globally networked, smart technology-based welfare society that constantly renews itself. Smart technology and information networks improve the synergies between the local and the global.

KL-Kuntahankinnat offers *municipal buying power based on procurement services*. *Its service offering covers expert services, tendering framework agreements, contract managing,* etc. Its focus is on large-volume agreements to bring significant benefits in the form of cost savings, process advantages and where local supply is more limited. KL-Kuntahankinnat Oy is owned by Kuntaliitto.

APP. B Healthcare service cluster

Healthcare *service cluster* includes private healthcare service companies and organizations. Some of them focus on elderly care services, some on healthcare services and some focus on both. The recent big-picture idea is a trend toward consolidation.

Yrityksen nimi	Liike-vaihto milj. €	Liikevaihdon kasvu-%	Liiketulos milj. €	Liike-tulos %
Attendo Finland *	453,0	**10,5**	..	..
Mehiläinen	445,5	**65,7**	23,0	5,2
Terveystalo	325,2	**6,7**	19,3	5,9
Pihlajalinna	213,3	**43,3**	4,5	2,1
Esperi Care	126,4	**4,6**	8,7	6,9
PlusTerveys	120,8	**-1,8**	17,6	14,6
Mobility Finland	101,9	**4,4**	2,5	2,4
Coronaria Hoitoketju	90,6	**69,5**	5,1	5,6
Mainio Vire	87,4	**4,4**	1,8	2,0
Silmäasema Fenica	85,0	**8,7**	4,5	5,3
Mi-Hoiva	82,3	**23,6**	-3,2	-3,9
Diacor terveyspalvelut	78,8	**4,9**	3,0	3,8
Renideo Group (Oral Hammaslääkärit)	71,4	**18,0**	3,4	4,8
Med Group	54,2	**7,4**	2,4	4,4
Aho Group**	51,1	**5,3**	0,5	0,9

* Attendo ei tee Suomessa konsernitilinpäätöstä ** 2015/3

LÄHDE: KAUPPALEHTI, BALANCE CONSULTING

Figure 50: The largest health and care service companies in Finland[20].

The four biggest healthcare service providers are **Attendo, Mehiläinen, Terveystalo Healthcare** and **Pihlajalinna.**

The **Cor Group** service offering includes *healthcare and optics, media, technology, housing and services development*. The Coronaria Care Chain produces and supplies versatile healthcare services ranging from basic healthcare to special healthcare, and from home care to supported living options and physical exercise-oriented daycare services. **Mectalent** is a part of the Cor Group. It develops *surgical instruments and offers also contract manufacturing services in precision mechanics*.

[20] Kauppalehti News 13.6.2016.

Attendo provides *healthcare services* in Nordic countries, employing 20 000 caregivers for older people and care for people with disabilities and individuals and families, as well as healthcare, medical and dental care at more than 500 different facilities throughout Sweden, Finland, Norway and Denmark. Only healthcare services are provided in Finland, covering primary care, specialist care and dental clinics. Attendo offers also dental services and operates its own dental clinics.

Mehiläinen provides *social and healthcare services* almost everywhere in Finland and is the largest private provider of social and healthcare services. Mehiläinen has 290 units and employs more than 11 500 professionals in healthcare and social care services. Mehiläinen`s mission is individual well-being, and a well-being society; the individual person is always at the core of services. Mehiläinen makes an effort to meet customers individually and holistically, while constantly developing the quality of services and patient experience. LähiTapiola acquired 10% of Mehiläinen in 6/2017. Collaboration aims to focus on care process development, digital health services, new insurance concepts and a nationwide service network.

Esperi Care is among the leading *private social care and health service* companies in Finland with over 4,000 employees. Espier provides housing services for the elderly, disabled and those in rehabilitation, both private and public customers. All services are supported by Espier Medical Services Ltd.

Heltti is an *occupational healthcare service company* founded in 2013, owned by its employees and a handful of renowned Finnish investors, such as Risto Siilasmaa. The company aims to develop the *preventive digital healthcare systems* where two thirds of everything the company does is preventive healthcare. The company's earning logic is based on fixed fee per cared-for customer, not on on-site medical visits.

Kotitori is a public social and healthcare *service integrator* operating between municipal, private, third-party organizations and *customers.* The idea of Kotitori is to provide a "one-stop shop" for public and private home care services with easy access for older people and their relatives. The Kotitori concept was developed in the City of Tampere in a Tekes-funded FinnWell programme.

Luona is a private *social and healthcare service integrator* in the capital region, Tampere, Oulu and Rovaniemi. Luona is a subsidiary of the Barona Group.

Megaklinikka provides *dental services, related information systems and licenses.* Their special focus is a *digitally boosted service concept*.

Pihlajalinna provides *private social and healthcare services* in Finland. Pihlajalinna provides social and healthcare services for households, companies, insurance companies and public sector entities in private clinics, health centres, dental clinics and hospitals around Finland. Pihlajalinna provides general practitioner and specialized care services, including emergency and on-call services, a wide range of surgical services, as well as occupational healthcare and dental care services, in private clinics and hospitals operating under the Dextra brand. Pihlajalinna aims to be a nationwide and comprehensive social and healthcare services provider for both private- and public-sector customers. Pihlajalinna's strong growth strategy is based on acquisitions. Pihlajalinna nearly doubled its revenues during 2015–2016.

Terveystalo is the largest *healthcare service company* in Finland employing 6,800 healthcare professionals through a nationwide network of 17 hospitals and over 170 units. Terveystalo offers versatile healthcare, occupational healthcare, medical and examination services in nearly 150 clinics around Finland. Our customers include private individuals, companies and communities, insurance companies and the public sector. The company offer a wide variety of integrated primary, secondary, occupational health and diagnostic care services. Since 2001 the company has made approximately 140 acquisitions. Today, the company is the Finnish market leader in occupational and private healthcare services, with around 500,000 occupational healthcare customers and 2.5 million doctor visits in 2015. Furthermore, it is well-known for its nationwide clinic network, leading IT solutions, as well as strong commitment to clinical, customer and operational quality.

PlusTerveys is one of the largest *private healthcare service providers* in Finland, owned by its employees. PlusTerveys currently has 100 locations and 1,200 employees.

PerusTerveys Suomi is a new (2015) private *healthcare service company* having two units in Oulu and one in Helsinki. The company aims to grow as a nationwide healthcare service provider and to open up dozens of new units.

Pohjola Hospital is building a countrywide *hospital and medical centre network* and opening up new specialist clinics in Finland's hospitals. It offers occupational healthcare services to OP Vakuutus corporate customers. The key focus area is orthopaedics. Pohjola Hospital cooperates with most insurance companies.

APP. C Healthcare foundations and associations

There are, in total, probably thousands of health- and elderly care-related foundations, associations and third-party voluntary organizations. This appendix lists only some examples.

The Caritas Foundation provides *healthcare, hospital, occupational health, rehabilitation and housing services* for private companies, municipal customers and citizens in Oulu employing about 500 workers.

The Finnish Medical Society Duodecim is a scientific association *providing education, information and grants to develop professional skills and clinical practice*. The Society's membership comprises more than 22,000 doctors and medical students and almost 100 member associations.

The Finnish Social and Health Informatics Association – FinnSHIA. FinnSHIA *publishes Finnish Journal of eHealth and welfare*, Finjehew.

The Helsinki Deaconess Institute is a foundation and a multifaceted social enterprise group with several subsidiaries. The group provides *wide-ranging social welfare, healthcare and education services.* Suomen Terveystalo Oy and the Helsinki Deaconess Institute Foundation have agreed on a merger between Diacor terveyspalvelut Oy and Terveystalo.

The Miina Sillanpää Foundation provides *rehabilitation services* for working-age and elderly populations, residential and other services for elderly people and *research and development that promote public healthcare*.

The Finnish Patient Insurance Centre *handles all personal injuries that occur in connection with healthcare activities* in accordance with the Patient Injuries Act.

The Finnish Student Health Service (FSHS) provides general, *mental and oral healthcare services* for students of universities and other institutions of higher education.

APP. D Healthcare management consulting and expert services

Healthcare management consulting companies provide their expertise to private companies and municipal organizations.

Aidertech provides *management consulting services* for international life science companies. Their service range covers strategic planning, market research, international partnering, OEM and licencing arrangements, IP strategy, acquisition and post-merger integration and board membership.

DRA Consulting provides *pharmaceutical consultancy* including such services as marketing authorizations, price applications, pharmacovigilance, wholesale activities and marketing in the Nordic Countries and Europe.

Evalua is specialized in *personnel surveys focusing on well-being and coping at work*, and related specialist consultation services. Evalua operates together with Terveystalo Occupational Health Services and Mutual Pension Insurance Company, Ilmarinen.

The Nordic Healthcare Group is specialized in *planning and developing health and social services* especially in Finland, Sweden and Russia.

APP. E Healthcare and wellness technology cluster

Medical and care furniture and equipment

Lojer develops hospital, physiotherapy and care equipment employing 120 people directly, and dozens more through subcontractors. Their wide product offering is supplemented with a broad product life cycle service portfolio. As an example, the Functioning Care Facility service concept ensures that a hospital or care facility always has safe, working equipment. Lojer owns and takes full responsibility for the equipment and its maintenance.

Merivaara provides a wide range of equipment and solutions for hospitals, day surgery and health clinics, as well as for nursing homes and home care, such as operating room equipment and integration systems, surgical tables, medical lights, stretchers, patient trolleys and hospital beds.

eHealth and telemedicine companies

Abomics is focused in *translating genomic information into clinical practice* in order to create value, that is to increase the safety and efficacy of medical treatments. Offered solutions cover pharmacogenetics interpretation services, pharmacogenetics database, oncogenomic database, drug laboratory effects, personal health account for genetic test results.

Acute FDS is focused on offering *patient information systems* for hospitals, occupational healthcare, health centres, physiotherapy services and the public sector. The Swedish-listed company, Vitec, acquired Acute FDS in 2013.

Ascom Miratel is a global solutions provider focused on *healthcare ICT and mobile workflow solutions*. Ascom offers solutions for improving communication and collaboration within hospital solutions that can help enhance patient safety, staff satisfaction and clinical workflows. Solutions include smartphone-based communication and wireless alert systems, nurse call integrated systems.

BC Platforms is a leading Swiss company in the field of *genomics.* The company focuses on *bioinformatics and genomic data management solutions*. Their offerings consists of data integration, interpretation and analysis for clinical applications.

DISE is a Swedish *digital signage software company*, aiming to be the leading software for digital signage through quality and performance and by applications of new technologies and technical solutions.

Dottli is a digital health company based in Finland. Dottli aims *at improving life with diabetes.* The *Dottli app plus web app for diabetes* is designed to help manage and monitor health better.

Ikoni Innovation develops consumer-oriented – both family-centric and personal – proactive & preventative *mobile applications for advancing dental health*. Applications provide education, entertainment and timing for children, and even a pro application for dentists to help them in the treatment of children.

Kide Clinical Systems specializes in delivering *clinical optical imaging solutions* to the medical industry. KIDE's software makes the clinical imaging process more effective and efficient for both physicians and patients. OPTOFLOW covers all the phases from device integration to image archiving and to telemedicine.

Mawell eHealth Systems (Mawell eHealth Systems was acquired by Norwegian CSAM Health in 2016). CSAM is a privately owned eHealth company based in Norway, *focusing on software solutions enabling healthcare providers to access relevant clinical information at the point-of-care*. CSAM is #1 in Scandinavia in oncology medication software, #1 in Norway in maternity software and #1 in Norway in emergency and acute care software.

MeeDoc provides *telehealth-based services to see the doctor*. The treatment list covers smoking cessation, prescription renewals & medical advice on skin conditions, migraines and headaches and eye infections. The service is based on a *live video connection* to a physician-enabled network of licensed medical professionals.

Medixine provides *monitoring and collaboration tools* for all parties involved in the care process and connects patients and care providers. The main *software product* is the Medixine Suite™. The module-

based software suite enables customers to choose the right combination of modules for achieving their goals in a cost-effective way. Patient Portal, Telehealth Monitoring and Remote Education and Coaching allow people to communicate with their care providers. Care professionals have access to patients' self-care data, can detect out-of-bounds patients, view population-level reports and communicate securely with patients.

Mylab Technologies provides *information services* for the healthcare sector, develops clinical laboratory information technology and is the *information system partner* of leading laboratory centres in Finland. For laboratories, offerings include clinical chemistry and haematology, genetics, automation and analytics integration. For care units and patients there are services such as a browser-based *test results interface, SMS messages and the Itella iPost Service*.

Onesys Medical develops *minimally invasive brain surgery technology and methods to handle the massive needs already apparent in industrial-scale digital healthcare information systems* (EMR, PACS). One of the recent innovations is the so-called *Pen navigator*, which enables visualization of medical imaging data. Using inertial sensor technology it is possible to examine a patient's MRI images during the patient visit, for example.

Coronaria Analyysipalvelut (previous Remote Analysis) develops *telemedicine technology and solutions* for healthcare service companies, medical health stations and occupational healthcare service companies.

Care and rehabilitation companies

Ani Biotech develops *rapid tests* for laboratory, physician offices, and home use. The product portfolio covers fertility tests, ovulation, and menopause, infectious disease tests, autoimmune disease and cardiac markers. The company also provides products for veterinary and food hygiene purposes. In addition, its products include a celiac disease test utilizing whole blood fingertip samples, and third-generation pregnancy and ovulation tests. The company's products are used with fertility hormones, bacterial, and viral antigens and antibodies.

Bioretec is a *material technology company* focused on the development *of bioabsorbable, bioactive and drug-releasing surgical implants* for orthopaedic, trauma and sport medicine surgeries.

Diter (prev. Diter Elektroniikka) develops *medical, physiotherapy and beauty/cosmetics equipment.* The product range covers isokinetic muscle strength testing equipment, ultrasound, radiofrequency and soft laser solutions. There are also products for home care, such as muscle simulator and pain treatment equipment and even animal care.

Glucostratus (prev. Mendor) develops *solutions for remote monitoring of blood glucose*. Solutions allow healthcare professionals to remotely monitor their patients' blood glucose levels between appointments. The system includes connected blood glucose meter, *balance cloud platform and intelligent analytics.*

HLD Healthy Life Devices develops *physiotherapy and lymph therapy devices* for (LymphaTouch and PhysioTouch) healthcare professionals. Products are already in use at approximately three hundred locations in various parts of Finland, Europe and the USA.

HUR offers *exercising products and services for senior exercise, rehabilitation and wellness* for professional exercise equipment for senior training, medical fitness and gyms. Computerized systems – HUR SmartTouch – enable automated individual training and tracking. HUR-services cover exercising concepts and layout design, financing, education, marketing support, *know-how and maintenance services*.

Kineso offers physiotherapists *a mobile visualized rehabilitation assistant and rehabilitation programme planning tool*.

Lunette develops *medical silicon-based re-usable menstrual cups*.

Modulight offers *laser and optic technology-based medical applications/devices* for personalized medicine. The company provides biomedical lasers for oncology, genetics and ophthalmology, laser solutions *integration services, laser design and manufacturing services*. Modulight works together with Finnish hospitals, international cancer clinics, R&D-units and medicine companies. Modulight is a spin-off company of the Optoelectronics Research Centre, ORC/TUT.

Onbone is a splinting *material and solution supplier suitable for occupational therapy, orthopaedic (orthosis) and traumatology* uses. Splints are made from wood chips and biodegradable plastic and can be moulded without water or gloves.

Serres is originally a plastics company, specialized in developing su*ction bag systems, suction ejectors and suction bag emptying systems* for surgeries and hospitals. Serres is the largest European manufacturer and the second largest globally.

Sooma is a medical device company *developing non-invasive brain stimulation devices* for treatment of neurological and psychiatric disorders. The company offers non-drug treatment options for major depressive disorders (MDD).

Stick Tech develops fibre *reinforcements for dental purposes*. The most well-known everStickC&B product is used for strengthening composite bridges and crowns in dental practices and laboratories. Products are used in more than 30 countries around the globe.

Valon Lasers makes high-speed *galvanometric laser scanners* for PRP (Platelet Rich Plasma) *photocoagulation purposes*.

Telia (Sonera) provides *telecare solutions and platforms for homecare*.

In vitro diagnostics and laboratory solution companies

Abacus Diagnostica is a *molecular diagnostics company specialized in rapid DNA testing. The* company's mission is to provide innovative, affordable and easy-to-use solutions to enable *routine use of DNA-based clinical diagnostics*.

Arctic Diagnostics develops *in-vitro diagnostics systems and biomolecule detection technologies.*

Aurealis develops *immune modulation technology* to modulate and re-educate the distorted host immune microenvironment to a proper state in chronic inflammation and cancer.

Biohit Healthcare specializes in the development of products and analysis systems for the *early diagnosis and prevention of gastrointestinal diseases*. Products include the blood sample-based examination for the diagnosis of stomach illnesses and associated risks, biopsy quick tests for the diagnosis of lactose intolerance and helicobacter infection in conjunction with gastroscopy.

Biovian engages in *process development, scale-up and contract manufacturing of biopharmaceuticals*.

Bioxid develops *new biomaterials used in dentistry, orthopaedics, and different clinical areas* like oncology.

Blueprint Genetics provides *clinical gene testing and customized sequencing services*. Services include one-off sequencing projects, tailored sequencing and bioinformatics platforms to address specific sequencing needs and custom services for researchers and diagnostics providers.

Brainshake is a *blood testing solution company bringing biological data to routine healthcare*. A single blood test covers over 220 metabolic biomarkers for chronic diseases and this data is the key to predicting and preventing individual disease risk affordably. The technology is globally available as a service from Brainshake's laboratory or locally for customers wishing to apply the test on-premises. Brainshake has estimated that their target market is around 650 billion dollars.

Finnish Red Cross keeps a *stem cell registry* for finding a suitable donor for a leukaemia patient.

Hytest manufactures *monoclonal antibodies and antigens* that are mainly used as key components of laboratory tests. Hytest products can be used in several clinical areas including cardiac markers, infectious diseases, metabolic syndrome and veterinary diagnostics. Hytest is a key raw material supplier for the entire IVD industry.

Labsystems Diagnostics develops *diagnostic solutions/tests* for neonatal screening (NBS), infectious diseases and clinical biochemistry, including gastroenterology and cardiac marker POC tests. Test solutions can be used on clinical laboratories, at home and at doctor's offices. After the acquisition by the India-based global

healthcare group Trivitron, Labsystems Diagnostics Oy raised the bars in the in vitro diagnostics sector.

Medix Biochemica develops *monoclonal antibodies, antibody services and recombinant antigens for the IVD industry as well as diagnostic rapid tests and materials* for human healthcare worldwide.

Magnasense Technologies develops *rapid point-of-care test diagnostics solutions for quantitative determination of biomarkers (such as CRP). The solution is based on* lateral flow tests utilizing paramagnetic particles as a label. Solutions can be applied in medical and veterinary diagnostics, food safety and environmental monitoring.

Mobidiag is a biotechnology company specializing in *developing solutions for molecular diagnostics of infectious diseases*. Mobidiag has merged with a diagnostic platform developer, Genewave, and a stool-based clinical assay development company, Amplidiag.

MODZ offers *blood glucose meters* that remind you to measure blood glucose. You set your meal times and reminders of your daily rhythm. Measurement results are saved in the device's memory and automatically and wirelessly uploaded into the MODZweb web result service. The results are also sent to a selected receiver via SMS.

Orion Diagnostica develops *diagnostic test systems* for healthcare professionals.

Sartorius AG (prev. Sartorius biohit liquid handling) offers *pharmaceutical and laboratory equipment*.

Thermo Fisher Scientific is a global world leader of life sciences research and patient diagnostics. Thermo Fisher acquired Finnish-based reagent, instrument and consumables manufacturer, Finnzymes, in 2010.

Trivitron Healthcare is a global Indian-based medical technology company providing diverse healthcare solutions. Trivitron Healthcare acquired Finnish-based diagnostics companies Ani Labsystems and Ani Biotech in 2012.

UPM Biochemicals *provides wood-based cellulose nanofibril hydrogel for 3D cell culturing and other biomedical applications*.

GrowDex® is highly biocompatible with human cells. UPM aims to develop nanocellulose-based *wound care applications*. UPM Biochemicals and The Institute for Molecular Medicine Finland (FIMM) have started a joint research project with the purpose of investigating the applicability of UPM's new cellulose-based gel material for cancer research.

Varian produces tools that harness the power of X-ray energy to benefit humankind. Varian´s history is based on developments in the fields of radiotherapy, radiosurgery, *X-ray tube technology, digital image detectors*, cargo screening, and non-destructive testing. Varian staff is over 6,500 people in 70 sales and support offices around the globe is developing innovative, cost-effective solutions that help make the world a healthier place.

Measurement, monitoring, imaging and personal well-being technology

Beddit develops *sleep tracking solutions* that accurately measure sleep, heart rate, breathing, snoring, and the environment. Beddit was acquired by Apple in May 2017.

Bone Index develops point-of-care, hand-held *bone index measuring instruments* – Bindex bone sonometer *plus apps* – to help in osteoporosis diagnosis. The device detects osteoporosis with 90% sensitivity and specificity, helping significantly physicians with diagnosis. The mission is to reduce the number of osteoporotic fractures globally by one million per year.

Botnia Scan provides *mobile MR-imaging services* at a reasonable price level all over Finland. Botnia Scan works together with hospitals, health centres and private centres. MRI-device leasing is an option.

Clothing+ develops *biometric sensor electronics* for sports textiles and medical applications. Clothing+ was acquired by Jabil Circuit Inc. in 2015.

Delfin Technologies develops hand-held *wireless skin parameter and edema measurement instruments and related software* for data collection. Applications cover medicine, pharmaceutical industry,

personal care industries, testing labs and CRO´s and animal health and zoology.

Danaher offers *diagnostics, life sciences, dental and environmental and applied solutions w*ith more than 30 operating companies.

Extensive Life develops *web and mobile tools to manage a personalized lifestyle*. The company makes health activity data gathering easier through sensors and mobile applications. It customizes services to support different lifestyles, demographics and health conditions of individuals and communities, including health kiosks, health analytics, nutrition tools and many others.

Emfit develops contactless under-the-mattress-located, *sensor-based health technology products.* The sensors measure vital signs, paediatric night-time seizures, athlete recovery, and hospital bed occupancy. Data can be measured and recorded wirelessly. The company is also expanding to sleep apnoea diagnostics.

Heart2Save offers *smart phone- and medical device-based solutions to prevent stroke*.

Icare Finland develops eye *measuring instruments plus software for data collection with suspected glaucoma and daily intraocular pressure monitoring* for eye care professionals and home use. Icare Finland is a part of the Revenio Group Corporation, a public company listed on the Helsinki Stock Exchange.

Injeq develops *smart needle products and related information technology*. Smart needle implies its capability to identify the tissue at the tip of the needle. Smart needles improve current practices by providing an alert when the tip of the needle comes in contact with spinal fluid. Injeq continues clinical research of new solution areas: lumbar puncture to obtain diagnostic spinal fluid samples and a biopsy system that integrates tissue identification by a core biopsy needle.

Innomentarium provides a wide range of *services a*nd products for both private and public healthcare; the *key product area is software-supported diagnostic imaging systems*.

Medikro develops *medical measuring instruments and software for pulmonary diagnostics* and monitoring for healthcare professionals, patients and partners.

Mediracer develops point-of-*care diagnostics technology* in the field of clinical neurophysiology for patient examinations adapted to the needs of primary healthcare. Product portfolio includes examination nerve tunnel at the elbow (carpal tunnel syndrome=rannekanavaoireyhtymä).

Mega Elektroniikka is a medical technology company specialized in *bio signal monitoring* for cardiology, neurology, rehabilitation, occupational health and sports medicine.

Nexstim (prev. Neuroway Technologies is a medical technology company focusing on improving *rehabilitation for stroke patients through the use of noninvasive brain stimulation.* Nexstim has pioneered the technology for brain diagnostics with its Navigated Brain Stimulation (NBS System). Based on the same technology platform Nexstim has developed a device for stroke therapy called Navigated Brain Therapy (NBT® System). Solutions are in validation process/pre-commercialization phase. In the pre-commercialization stage prior to full commercialization, the manufacturer aims to obtain key opinion leader (KOL) support and to show the economic benefits of the device to different parties. Nexstim applies a value-based approach to the health economics model, which is built around the interplay between patients, healthcare providers and payers.

Ocusweep (prev. Ocuspecto) develops *neuro-visual testing devices (field of vision), and a cloud service to store and deliver the measurement data*. The device (Ocusweep) is targeted to high-volume primary health-care and opticians/optometrists. Ocusweep and the cloud service belongs to a mandatory service plan. There are plans to charge per test executed, and give the device out at lower cost, in order to gain higher long-term profitability.

Oivauni is specialized in *sleep medicine – diagnosing and treating sleep disorders*.

Optomed is a medical technology company that specializes in *retinal imaging devices and solutions*. With an *information technology-based workstation* you can view, analyse and compare retinal images with one simple graphical interface and manage data. The

product portfolio consists of digital imaging instruments that provide retinal and eye anterior imaging with one portable device. The key product is Smartscope® PRO, a modular hand-held retinal camera for screening and diagnosis of various eye diseases, such as diabetic retinopathy, glaucoma and AMD.

Optomeditech develops *IV (intravenous catheters) technology* to increase the first attempt success rate of catheter starts and to make the process faster, safer and easier both for the caregiver and the patient. It uses trans illumination of skin tissue to aid in cannulation. Innovation consists of an integrated optical fibre, and an electronic unit. The electronic unit is a portable, internally powered generator of low-power visible laser light of a green colour.

Seniortek develops *safety solutions and communication systems* for assisted living, home care, schools and nursery schools.

Sensotrend is a start-up company *specializing in type 1 diabetics and making living with diabetes easier*. The offering is a *diabetes dashboard* aiming to improve treatment through automated data collections, enhanced visualizations, and easy sharing. The company aims to give patients full control over their data.

Spektikor specializes in single-use *first aid and other medical electronic devices*. The Spektikor *heart beat indicator* makes it possible to easily monitor a patient's heart rate in any environment and also on the move, in the dark and in noisy environments. It makes it possible to monitor multiple patients in incidents.

Suunto develops *sports watches, instruments and dive computers.*

Artificial intelligence

Curious AI *develops artificial intelligence*, more specifically machine learning technologies. Potential end applications include, e.g. novel machine vision technologies for autonomous vehicles, advanced software agents and intelligent personal assistants.

Fimmic is a software company *developing deep learning image analysis for digital medical microscopy*.

Solita is a digital *business consultancy and digital services company*. Solita has developed, together with DNA a data platform, an analytics solution *that utilizes artificial intelligence* and improves customer service and experience.

Ultimate AI develops *artificial intelligence-based chat robots and customer service solutions*.

APP. F Medical and healthcare ICT and data-based solutions

Addoz develops *intelligent dispensing systems* for medication (product name in Finnish is “lääkekello”).

Atostek provides *medical and healthcare ICT, software solutions and IT expert services for product development*. Atostek eRA is a cloud service that allows linking any Patient Information System to Kanta Services by KELA. The service includes an easy-to-use browser user interface to see and write online prescriptions and patient records and it can be used as a stand-alone application too.

Acute FDS develops *healthcare information systems*.

BetterDoctor *offers healthcare data services* so patients can quickly get the care they need, when they need it.

MediSapiens is a Bio-IT company, *offering technologies and services to build customer-specific Bio-IT solutions*. MediSapiens are experts in bioinformatics, genetics and software development with tens of years of combined experience. It serves the market with genomic, biomedical and clinical platforms, d and scientific and data services.

Odum provides smart *digital health solutions* (AlvinOne) to companies and healthcare service providers. Odum and VTT have developed an application that predicts health risks and guides users on how to proceed according to their results. During the project, the researchers at VTT developed an algorithm that predicts future health risks.

Evondos develops *automatic medicine dispensing robots* installed at the patient’s home, and the telecare system, which has a wireless connection to the dispenser. Evondos medication services utilizes multi-dose sachets offered by pharmacies.

Elekta develops *equipment, software and services to improve, prolong and save the lives of people with cancer and brain disorders.* Treatment solutions and oncology informatics portfolios are designed to enhance the delivery of radiation therapy, radiosurgery and brachytherapy (lyhytetäisyyksinen sädehoito). The company is

headquartered in Stockholm. Elekta is listed on NASDAQ Stockholm. Software solutions brings together the people, the workflows, and the information clinics needed to deliver quality care and smoothly run operations.

Hapella has developed an advanced *respiration therapy device*, WellO2, for all who suffer from acute or chronic respiration problems.

M-Files is focused on *enterprise information management solutions* disrupting the ECM (equity capital market) market by eliminating information silos and providing quick and easy access to the right content from any core business system and device.

NewIcon develops medical service automation. Product offering *includes drug storage and retrieval automation, smart medicine cabinets and consulting, design and maintenance services.* The European Investment Bank (EIB) has granted NewIcon an 8 million euro loan for funding.

TAKSO offers *medical device consulting and ICT services*: quality management systems, CE Mark and medical device consulting and project management services. TAKSO has deep understanding of medical device regulations and medical device technology, due to its decades-long experience of working with both start-ups and global giants in the sector.

9Solutions offers *healthcare safety and communication solutions* for hospitals, home care and care homes. 9Solutions is the market leader (ca. 25%) in care home solutions: 4.5 billion location updates monthly, 10.000 alarms daily and 400 healthcare customers. The location information solution covers the location of people and devices, nurse call, assault alarm, area control and automatic locking system and operative situation snapshot.

Association of Finnish Pharmacies AFB *provides training and communication services to its member pharmacies*. AFB maintains *Database of Pharmaceutical Preparations* and a *product database* and produces product files for member pharmacies, authorities and subscriber customers.

Ascom is a global healthcare *ICT solution provider*. Ascom's vision is to close digital information gaps, allowing for the best possible decisions – anytime, anywhere. Ascom has over 12,000 hospital installations globally.

Biisafe offers *wearable safety devices and related software*, and the main product is the BiiSafe Buddy. It works together with the jewellery brand, Kalevala Koru.

Carecode offers *communication information systems* to professionals to communicate with each other and their patients, whenever and wherever. Carecode provides services in Finland in co-operation with Telia.

Clothing+ develops *sensory clothing solutions* to improve overall health and well-being. It operates together with Suunto and Firstbeat. It was acquired in 2015 by Jabil Circuit, USA.

Elsi Technologies offers *under-floor censoring* and *software solutions* for care homes.

Ekahau provides *Wi-Fi-based* RTLS (RTLS=Real Time Location System) *solutions*.

Emfit provides *sleep analytics, seizure monitoring solutions and smart sensors*.

Espotel offers *engineering services, embedded systems and IoT, as well as technical documentation solutions* for the medical industry. Espotel is part of Etteplan.

Foibos provides home *care services for cancer patients* managed by specialist-level doctors. Services cover IV antibiotics, blood product treatments, laboratory tests and 24/7 patient monitoring.

Gillie.io develops *ICT-solutions for connecting devices* and separate information systems as connected solutions for elderly home care. Gillie.io works together with 9Solutions, Addoz, Beddit, DomaCare, eezy, E-Hoiva, Emfit and Fastroi.

Ginolis offers *assembly automation and liquid handling solutions* for the medical device and diagnostics industries.

Kuori offers *large smart screens and integrated ICT-solutions* for care homes and public facilities.

Mendor offers *solutions for remote monitoring of blood glucose*.

Orion Diagnostica develops *diagnostic test systems* for healthcare professionals.

Videovisit provides *digital telehealth/eHealth solutions* healthcare service providers integrated into healthcare service processes. VideoVisit acts as KL-Kuntahankinnat service provider for all public sector organizations for virtual home care and online doctor appointment and consultation solutions.

Vivago develops smart *safety and well-being solutions* for preventive care.

Tunstall provides ICT *technology-enabled health and care solutions* for independent and assisted living, remote patient monitoring and support and integrated nurse call systems.

Engineering and manufacturing services

Elomatic provides *engineering and consulting services* for the biotech and pharmaceutical industry.

EOS Finland provides an *additive manufacturing technology* base AM-technology services for dentistry, orthopaedics and medical services.

Etteplan provides *engineering services*, focusing on embedded systems and IoT as well as technical documentation solutions. Etteplan provides *engineering services also for medical product and device purposes*, such as point-of-care devices, diagnostics equipment, rehabilitation aids, dental equipment, electro medical & imaging equipment, sterilization equipment, orthopaedics, anaesthesia equipment, respiratory equipment and surgical instruments.

Innokas Medical provides *product development, contract manufacturing and quality & regulatory services* for healthcare companies. Solutions cover the entire path of bringing new medical products to the market.

Mariachi specializes in *development and contract manufacturing of advanced devices or instruments*. Customers are recognized suppliers of medical devices, industrial systems and information technology. Mariachi offers also the *Kasvattamo programme for start-ups* and inventors, aimed at helping innovations to reach the market faster and with greater success.

Mectalent provides *component manufacturing and precision mechanics services*. Their focus is on new technology, *medicine* and the defence industry, and strengths in precision, security and monitoring mechanics, method development, component manufacturing, *surgical instruments and implants.* Mectalent is a part of Cor Group.

Servicepoint provides *serialization manufacturing automation* for the pharmaceutical industry and other fields of industry.

TactoTek provides *injection-moulded structural electronics* that integrate flexible printed circuitry and discrete electronic components into mass-produced injection-moulded plastics.

APP. G R&D&I cluster

The R&D&I cluster includes nearly ten universities, a few universities of applied sciences, private R&D organizations, private CRO organizations, PPP organizations and start-up accelerators.

Universities and co-operatives

Aalto University is a multidisciplinary university where science and art meet technology and business. *Health and well-being* is an area of academic excellence and one of the university's seven key research areas. *Health and well-being expertise includes medical and wellness devices, data science and software engineering for healthcare and well-being, biomaterials, biotechnology, and pharmaceuticals*. Aalto hosts the *Aalto Health Platform* to deepen and widen work with partners – including companies, both large and small. The platform supports our health and well-being research and facilitates the creation of business from our technologies

Helsinki University HU is the oldest and largest institution of academic education in Finland with an international scientific community of 40,000 students and researchers. *HU has a Faculty of Medicine and Helsinki Institute of Life Science (HiLIFE)*.

Jyväskylä University JU is an internationally renowned research university and an expert in education that focuses on human and natural sciences. The *Faculty of Sport and Health Sciences* is the only of its kind in Finland. Faculty topics are Sport Paedagogy, Sport and Exercise Psychology, Adapted Physical Activity, Dance Paedagogy, Social Sciences of Sport Biomechanics, Exercise Physiology, Science of Sport Coaching and Fitness Testing, Gerontology and Public Health, Physiotherapy, Sports Medicine and Health Education.

Oulu University OU is an international *science university creating innovations for the future, well-being, and knowledge through multidisciplinary research and education.* The *Faculty of Medicine (FMed)* has an Institute of Biomedicine, Institute of Diagnostics, Institute of Dentistry, Institute of Clinical Medicine and Institute of Health Sciences. There is also a *Faculty of Biochemistry and Molecular Medi-*

cine (FBMM). The *Centre for Health and Technology (CHT)* is innovating, connecting health solutions with researchers and entrepreneurs by:

- building a strategic innovation agenda to execute novel spearhead themes,
- coordinating multidisciplinary research, development and innovation activities in the OuluHealth ecosystem,
- supporting ecosystem members in their progress towards the commercialization and deployment of novel healthcare solutions,
- enhancing ecosystem innovation capacity through the development of agile innovation processes and models, and
- facilitating strategic cooperation through international networks and partnerships.

Oulu Innovation Alliance OIA integrates know-how from printed intelligence, *well-being technology*, cleantech and 3D Internet and brings together research institutions, businesses and public sector organizations. OIA generates cutting-edge global business from research, development and innovation projects and ventures. Current partners are the City of Oulu, University of Oulu, Oulu University of Applied Sciences, VTT Technical Research Centre of Finland, Technopolis Plc, Oulu Region Joint Authority for Education, Oulu University hospital, and Luke Natural Resources Institute Finland. OIA runs five ecosystems: Northern City with Attractive opportunities, Agile Commercialization ICT and Digitalization, Industry 2026 and OuluHealth. *Business Kitchen* hub is a community and co-working space to boost action and discover new opportunities in business and in life.

University of Turku is an international research university and an active academic community of more than 25,000 students and employees. The University has several internationally distinguished research concentrations including thematic collaborations in *biofuture, bioimaging, drug development and diagnostics.*

University of Eastern Finland UEF is a multidisciplinary university, which offers teaching in more than 100 major subjects. UEF has four

faculties: the Philosophical Faculty, the Faculty of Science and Forestry, the *Faculty of Health Sciences*, and the Faculty of Social Sciences and Business Studies.

Tampere University TU has strong expertise in the research on health and society. It educates shapers of the future who understand the world and change it. The focal areas of the *School of Medicine* include research on atherosclerosis, prostate cancer, celiac disease and vaccine development. The University is also internationally known for, among other things, research on diabetes and stem cells. The BioMediTech institute is conducting research on cell biology, biomaterials and biotechnology. The School of Health Sciences has for long conducted cutting-edge research on cancer epidemiology. The medical research and education are concentrated on the University's Kauppi campus close to Tampere University Hospital. Other institutions, such as the Tampere Biobank and *FinnMedi* Ltd., can also be found in the area. FinnMedi Ltd. focuses on the life science field and offers clinical drug trials and business development services. FinnMedi Oy is responsible also for the implementation of the Tampere Health Village development, which will unite health technology, healthcare and well-being in a whole new way. HealthHUB is part of the Tampere Health Village development project.

University of Tampere UTA has the *Faculty of Medicine and Life Sciences* and combines studies and research in biotechnology and medicine. UTA co-operate with the universities of Tampere and Helsinki, the Ministry of Economic Affairs and Employment. The *BioMediTech Institute* is a joint research institute of the University of Tampere and Tampere University of Technology. BioMediTech, brings together a mix of multidisciplinary expertise in life sciences and medical technology. Research and education fields are molecular biology, genetics, biomaterials, biosensors, computational systems, biotechnology, biomedical engineering, and regenerative medicine. The institute aims not only to integrate and strengthen the local tradition of excellence in basic life-science research and teaching, but also to create new platforms for discovery and innovation.

Laurea University of Applied Sciences provides four fields of studies: business, *nursing,* social services and hospitality management. Laurea offers a *bachelor's programme in healthcare studies*.

Savonia University of Applied Sciences is one of the largest and most versatile universities of applied sciences in Finland. Our organization of experts educates strong professionals in six different fields of study. Our campuses are situated in Kuopio, Iisalmi and Varkaus.

Biocenter Finland BF is a distributed national research infrastructure of seven biocenters in six Finnish universities: Biocenter Kuopio (University of Eastern Finland); Institute of Biotechnology, Biocentrum Helsinki and FIMM (University of Helsinki); Biocenter Oulu (University of Oulu); BioMediTech (University of Tampere); BioCity Turku (University of Turku & Åbo Akademi University). BF provides research services to the entire Finnish research community, in academia and industry, and to a limited extent also to users abroad. All services are based on the concept of open access. Technology services are provided by BF infrastructure networks in bioinformatics; biological imaging; genome-wide methods; model organisms; proteomics and metabolomics; stem cells and biomaterials; structural biology and biophysics; translational research technologies; and viral gene transfer and cell therapy. Through its infrastructure networks Biocenter Finland is also actively involved in the development of **pan-European infrastructures on the ESFRI Roadmap.**

Institute for Molecular Medicine Finland FIMM advances new fundamental understanding of the molecular, cellular and etiological basis of human diseases. This understanding will lead to improved means of diagnostics and the treatment and prevention of common health problems. Finnish clinical and epidemiological study materials will be used in the research.

Finland's Biobanks *provides biobanking/big data services*.

Kuopio University Hospital provides *biobanking services* for R&D purposes.

The Finnish Hematology Registry and Clinical Biobank FHRB is a non-profit organization providing *biobanking services* and makes them available to researchers in accordance with a set of predefined criteria. The goal is to develop novel methods for the diagnosis and treatment of haematological disorders and to improve the prognosis of patients suffering from these disorders. The biobank's operations are funded by its owners, by the hospitals providing the samples and by the researchers who use them.

Private CRO-organizations

Clinius is a *device CRO (contract research organization) with a main focus on clinical trials and regulatory consulting.* Clinius supports companies in the healthcare and well-being industry in understanding the needs of customers as well as meeting regulatory requirements.

Conforman provides *product requirements (regulation, standards) management expert, training and information services*.

Crown CRO provides *pharmaceutical, biotechnology, functional food and device* sector *CRO-services/coordinating trials.* Its track record includes 630 clinical studies and currently 100 active clinical trials are ongoing.

Finnish Red Cross provides *biobanking services*, in addition to blood products.

General Finland co-operative provides a *collaboration platform* for selected business areas, such as infrastructure, industrial, agriculture/forestry and well-being.

Kasve provides *R&D, quality assurance and business development services*, to help pharmaceutical and medical device companies reach international exposure and market insight. Kasve has vast knowledge in both medical device and pharma regulations and business networks around the globe.

Level Group offers *product development and productization services as well as innovative digital solutions* for several industries and product sectors. Health sector examples are:

- Wellness products, such as sports computers, heart rate monitors and products related to the well-being and safety of older people;
- Medical and in-vitro diagnostic devices, such as blood glucose and ECG monitors, for home and remote use;
- Hospital, treatment and laboratory applications, such as analysers, measurement of biosignals, and components of surgical equipment and imaging systems

Medfiles is the biggest private CRO-service company in Finland. Their service range includes *pharmaceutical development and analytical services, drug studies, medical device investigations, regulatory affairs related to medicines, health economics/market access*, and pharmacovigilance, and consultation on the above-mentioned areas.

Mectalent Medical Services provides *expert services for medical companies* globally. Services cover *product registrations, CE-markings, sales approvals* in the USA, quality management systems and authorized EC representative services.

Nextfour Group specializes in *product development for medical*, industrial and safety segments. Services cover each phase of a product's life cycle. Software and electronics design expertise, a wide showcase of product development projects and complementary partner network make Nextfour a one-stop shop for your productization needs.

Optofidelity provides *robot-assisted testing services*, tailored testing systems and testing software for global mobile and smart device players in various industries. Medical industry solutions include a machine vision system for checking markings and test platforms.

SGS Fimko Testing & Certification Services is a leading *inspection, verification, testing and certification c*ompany. Services cover multiple industry areas, such as life sciences.

Taipuva Consulting is specialized in *improving the competitiveness of your product development and functions associated* with it. Customer references cover also the medical industry, such as Innokas Medical, Planmeca and Suunto.

VTT Technical Research Centre of Finland is the leading *research and technology company* in the Nordic countries. VTT develops new *smart technologies, profitable solutions and innovation services*. **VTT Expert Services Ltd.** offers versatile *expert services, certification and product approval services, testing and inspection services and calibration services for medical devices*.

PPP-organizations and accelerators

Etelä-Pohjanmaan Terveysteknologian Kehittämiskeskus EPTEK is a regional development organization *aiming to adapt information technology into healthcare*. EPTEK creates new procedures with regional, national and international development projects. EPTEK services include *project coordination, consultation, education and technical support*. Ongoing projects: Nordic Telemedicine Center(opened 2016) and eHealth for regions.

Finnish Information Society Development Centre TIEKE has a key *networking role as a neutral and non-profit organization* promoting the efforts of its members, within the public and private sectors alike, with an ultimate goal to create viable tools and expertise for use in the information society. TIEKE´s main functions reflect the rapidly changing ICT environment in being flexible to change course from time to time according to need.

HeathSpa is a non-profit *incubator organization supporting healthcare start-ups*.

OYS TestLab is a *healthcare technology and service innovation and development laboratory*, operating jointly with Oulu University Hospital. It offers a real-life environment for healthcare product development. OYS Test Lab is a part of the OuluHealthLabs unit, based on co-operation between Pohjois-Pohjanmaan sairaanhoitopiiri, Oulun kaupunki/hyvinvointipalvelut, Oulun ammattikorkeakoulu, BusinessOulun and companies. PPSHP also runs the future hospital OYS20130 programme.

Prizztech Ltd. is a non-profit *business development organization* owned by municipalities in the Satakunta region.

SalWe is a *platform for cooperation between companies, universities, research institutions and healthcare professionals*. Its activities foster the international business operations of the health and well-being sector, and its social impact. SalWe produces research-based data that creates a competitive advantage for companies in developing products, services and practices. The focus is on maintaining and improving individual functioning. SalWe seeks to prevent, detect and treat diseases with serious social impact, such as brain dysfunction, injury and stress, lifestyle diseases, microbial infections and inflammation, and certain cancers. The common feature of SalWe's

activities is individually tailored monitoring and management of health, well-being and lifestyles. SalWe Ltd. has 33 shareholders, 19 of them companies and 14 research organizations. It was established in 2009 and, in the same year, was officially designated as a Strategic Centre for Science, Technology and Innovation in Health and Well-being.

Startup Health Finland is global (USA) leader`s entry in Finland in building early stage healthcare. StartUp Health Finland will co-locate in the Health Innovation Village at GE in Helsinki's 'Silicon' Vallila district and host regular programming and community events for entrepreneurs, innovators and healthcare transformers

Vertical is the first Nordic *healthcare sector start-up accelerator,* and may also invest in start-ups, up to 150 000 euros. 11 start-ups participated in the first group in 2015. Nokia and Microsoft are key stakeholders and it operates on private funding. Commercial partners and main funding organizations are Samsung Electronics and Telia (Sonera). Start-ups: Aid One, BetterDay, Bryom, Cardiolyse, Chino.io, Diske, DoctorPrice – Lääkärihinta, Effectus Labs, EHO, Enigma Bioctech, Etsimo, Fjuul, Force, Funiz, Happy Couple, Helathzed, Heimo, Huoleti, Intact, Kcalmar, Klinik, MedicSen, Miils, Minduu, Nairoby, Neqar Real, Newolo, Npoedic Hug, Optus, Pedius, Practigame, RICA, Sharewood, Via Esca, Vital Metrics, We did it, Wide, Winmill, XIMI and YuScale. Vertical has partnered with OP, the largest bank and insurance provider in Finland, to build innovative services that advance the way in which Finns will stay healthy and use health services in the future. The goal is to launch world-class health services for the Finnish market in cooperation with start-ups.

Vigo is an *acceleration programme* designed to complement the internationally acclaimed Finnish innovation ecosystem. Vigo is a acceleration programme designed to complement the internationally acclaimed Finnish innovation ecosystem. The programme bridges the gap between early-stage technology firms and international venture funding launched by the Finnish Ministry of Employment and Economy in 2009. The backbone of the programme is formed by the Vigo Accelerators, carefully selected independent companies run by internationally proven entrepreneurs and executives. These Accelerators help the best and the brightest start-ups to grow faster, smarter, and safer into the global market. The Accelerators are not

consultants – they are co-entrepreneurs who invest in the companies they work with to guarantee common goals and a passionate development effort. PROFict Partners Oy manages the execution of the programmes. At the moment, there are 8 Vigo accelerator programmes running. Vigo has been a huge success. There are over 150 accelerated companies (roughly 10–15% represent the healthcare and wellness sector), tens of exits and over 400 million euros worth of funding raised. **Finac** (Finnish Business Acceleration Network Association) is responsible for the Vigo activities and brand starting from 2 Feb 2016.

Profict Partners is specialized in *developing and evaluating the Finnish innovation system and coordinating national programmes for growth and internationalization*. Profict Partners manages the execution of the Vigo Accelerator Programme and Tekes Big Themes global market initiative in health and life science sectors. The latter has included three focus areas which are Home alone, Well-being and Diabetes. For example, the *diabetes network* includes seven Finnish companies which are: Evondos, Evalua, Extensive Life, Oivauni, Optomed, Mendor and Sensotrend.

APP. H Funding cluster

The funding cluster includes private funding companies, national public funding organizations and EU innovation funding organizations.

Private funding

CapMan is a leading Nordic investment and specialized *asset management company* and one of the Nordic private equity pioneers. CapMan has a diversified investment portfolio. From the healthcare sector, Oral Hammaslääkärit was founded 2014.

Cor Group is a Finnish *growth venture company*. The group's business operations are based on creating and recognizing successful new businesses, as well as on supporting the growth of companies. The primary business areas of the strongly product development-oriented group are healthcare, digital media, as well as housing and services development.

EQT is a leading *investments company* with funding portfolio companies in Europe, Asia and the US with total sales of more than EUR 19 billion and approximately 110,000 employees. EQT invests in companies, sectors and regions where there is an opportunity to make a genuine difference through the consistent application of an industrial approach, access to specialist expertise and a strategy geared towards growth and development. EQT has invested in Terveystalo.

Etera is a *mutual employment pension insurance company*. Etera invests the assets used to cover pension security. Etera primarily invests in the domestic market through *private equity and debt and real estate investments.*

eQ Group is a Finnish group of companies that *concentrates on asset management and corporate finance operations*. The share of the parent company, eQ Plc, is listed on NASDAQ Helsinki. The Group offers its clients services related to mutual and private equity funds, discretionary asset management, structured investment products,

investment insurance policies, and a large range of mutual funds offered by international partners. *eQ finances healthcare and elderly care real estate*.

Inventure is a leading *early-stage venture capital company* in the Nordics working with entrepreneurs in Finland, in the Nordics and the Baltics, supporting innovative start-ups and high-tech companies. Inventure are continuously looking for the brightest ideas to turn them into global superstars. Inventure´s portfolio includes Beddit, Blueprint Genetics, Valon Lasers, Miradore, Upcloud and Noona Healthcare.

Lifeline Ventures Fund Management *co-creates companies in health*, WEB, games, technology. Funded health companies include BetterDoctor, Mendor, Medisapiens and Sooma. Lifeline Ventures Fund Management was born during the Vigo-acceleration programme, which is included in the R&D&I appendix.

Mandatum Life (part of Sampo Group) provides *financial services* in Finland and Baltic countries.

Nexit Ventures is a *venture capital firm* focused on mobile & wireless innovation. Nexit invests primarily in Nordic and US-based companies with products and services for a global market. Nexit has invested in Ekahau (wifi-networks).

Pontos is a family-owned *private equity and real estate investment company* operating in Finland, the Baltic States and Portugal. Their portfolio includes genetics the company Blueprint Genetics.

Sentica Partners is an independent *private equity* company focusing on investing in and developing small- and mid-sized companies with a Finnish origin. Sentica has funded Pihlajalinna and Miratel (nurse call solutions). During Sentica's ownership Pihlajalinna acquired more than 20 other healthcare companies and carried out notable complete healthcare and social care outsourcings.

Trevian is an independent and management-owned r*eal estate investment and asset management company* focusing on commercial assets on the Nordic market. One of Trevian's focus areas is care of real estate investments.

Triton is a private *equity investor* investing in medium-sized businesses in Nordic region. Triton acquired, together with KKR (Kohlberg Kravis Roberts & Co.), the Mehiläinen Group.

Suomen Teollisuussijoitus TESI is a venture capital and private equity company that accelerates companies' success stories by investing in them, both directly and via funds. Currently funded health sector companies are NewIcon, Onbone, M-Files and Optomed.

R&D&I-funding

European Union's bank EIB is the world's largest multilateral borrower and lender. *EIB provides finance and expertise for sustainable investment projects* that contribute to EU policy objectives. EIB has provided an 8 million euro loan for NewIcon in 2016.

FinBioNet – Finnish Doctoral Programme Network in Life Sciences – is a national network of *doctoral training in biosciences and health sciences*. Its purpose is to promote research training cooperation and to coordinate research courses.

Academy of Finland *funds high-quality scientific research,* provide expertise in science and science policy, and strengthen the position of science and research. The Academy are an agency within the administrative branch of the Finnish Ministry of Education, Science and Culture. The Academy´s activities cover the full spectrum of scientific disciplines. In 2017, the Academy´s funding for research amounts to 437 million euros. Healthcare is ranked high in the Academy´s funding portfolio.

Finnvera provides *financing for the start, growth and internationalization of enterprises* and guarantees against risks arising from exports. Finnvera is a specialized financing company owned by the State of Finland and it is the official Export Credit Agency (ECA) of Finland.

Sitra aims to strengthen Finland's capacity for renewal, build a resource-wise and carbon-neutral society and develop a new working life and a sustainable economy. One of Sitra's development areas is called *impact investing*, which is a means of enhancing profitable cooperation between the private, public and third sectors by preventing

and solving various well-being and environmental problems. Hip fractures and type 2 diabetes are examples of medical conditions that cause significant problems for people and are usually preventable. Impact investing offers a way to make carefully planned, long-term, front-loaded investments. The impact investing team aims to import this new model to Finland: to build the *necessary ecosystem* for it, encourage various stakeholders – the public sector, service providers and investors – to join and test the effectiveness of the model in Finnish society.

Tekes provides *innovation funding for companies, research organizations, and public sector service providers.* For international companies Tekes provides easy access to the Finnish innovation ecosystem and helps companies start research and development activities in Finland. In the healthcare sector, Tekes and IBM have announced a partnership that will enable Finland to utilize Watson cognitive computing to help doctors improve the health of its citizens, and strengthen and develop the Finnish innovation and business ecosystem in the fields of health and well-being. To facilitate the collaboration, IBM intends to establish a Watson Health Center of Excellence in Finland, the first Nordic Healthcare Competence Center, and the first National Imaging Center of Excellence outside the United States, in Finland. These centres are expected to employ 150 people over the next few years.

Finpro *helps Finnish businesses grow internationally*, encourages foreign direct investment in Finland, and promotes tourism. Finpro's Finland Health programme attracts health sector investments to Finland and supports the growth of exports in the entire sector. Focus areas are senior care, rehabilitation & prevention, virtual hospitals and personalized healthcare. Finpro and Tekes will be merged 2017 under the job title ‘Business Finland’.

APP. I Authorities and municipal bodies

Ministry of Finance prepares the Government's *economic and financial policy* as well as the Budget, and acts as a tax policy expert. It is also responsible for preparing the financial market policy, the state's employer and personnel policy and developing public administration. In addition, the Ministry of Finance is responsible for developing the local government legislation as well as local government finances.

Ministry of Education and Culture is responsible for the *development of education, science,* cultural, sport and youth policies, and for international cooperation in these fields. Work carried out within the Ministry's administrative branch has far-reaching effects on people's well-being and success.

Ministry of Social Affairs and Health *prepares legislation and guides its implementation, directs and guides the development of social welfare and health services, and social welfare and healthcare policy,* defines social welfare and healthcare *policy guidelines*, prepares *key reforms and guides their implementation* and coordination and is responsible for links with political decision-making.

Ministry of Economic Affairs and Employment is part of the Government. MEAE's task is to build an *operating environment and to ensure productivity, growth, high levels of employment and well-being.* Health sector growth strategy for research and innovation is given in a guiding roadmap[21].

Kela is an independent *social insurance institution proving social security* coverage for Finns home and abroad. Social security benefits cover such things as family benefits, *health insurance, rehabilitation,* basic unemployment security, housing benefits and basic pensions. Kela operates under the supervision of the Parliament.

National Institute for Health and Welfare THL *promotes the welfare and health of the population, prevents diseases and social problems and develops social and health services*. THL carries out its objectives by means of research, development activities, official

[21] Innovating together. Health Sector Growth Strategy for Research and Innovation Activities. Roadmap for 2016–2018. Ministry of employment and the economy. MEE guidelines and other publications 8/2016.

tasks, steering through information, as well as international co-operation. THL maintains and promotes the use of a strong knowledge base within the field. THL runs *FinHealth Study*.

Finnish Medicines Agency Fimea *issues licences for pharmacies, hospital pharmacies and dispensaries and monitors the lawfulness of their activities, the safety of medicinal products manufacture and the marketing of medicinal products*. Fimea is the national competent authority for regulating pharmaceuticals operating under the Ministry of Social Affairs and Health. It promotes the health and safety of the population by *regulating medicinal, blood and tissue products, and by developing the pharmaceuticals sector.*

Regional State Administrative Agencies AVI is the *regional authority* in charge of *directing, licensing and overseeing healthcare*. AVI`s aim is to make sure that high-quality healthcare services are available for citizens. An AVI has six regional agencies in Finland. AVI´s tasks include direction and oversight of healthcare services, granting licences to private healthcare service providers, supervising healthcare professionals, quality management, complaints and discretionary and specified government transfers.

Supervisory Authority for Welfare and Health Valvira *guides, monitors and manages the administration of licences for the social welfare and healthcare sector*, alcohol administration and environmental health and protection.

APP. J Search methods

Information sources and tools

SEARCH SYSTEM – STN

Searches were performed on STN, a database host for professional searches and analysis with outstanding possibilities. It contains a wide collection of databases with broad coverage and value-added data.

DATABASE USED FOR SEARCHING

WPINDEX (Derwent World Patents Index): All technology areas. Over 23 million patent families covering 52 patent offices from the year 1963 onwards. A whole patent family is included in one record. Value-added data – new titles and abstracts written by real people in order to describe the invention in normal technological terms. Patent assignee codes are included.

ANALYSIS AND VISUALIZATION TOOL – STN ANAVIST

STN Anavist, an interactive text and data mining software offering a variety of ways to analyse search results and visualize patterns and trends into main players, technology sectors, geographic distributions, etc.

This tool is very useful in getting a general view on trends in patenting on a certain technology area or patenting of a certain company or organization.

Map – Documents are placed on the map according to the words they contain. Peak is formed on the map when documents containing similar terms are placed in the same area. The peak is named after the two most common words in the documents on it. The height of the peak corresponds to the number of documents. Documents on adjacent peaks are more related by their subject area than peaks far from each other.

Diagrams and matrices on main players, technology indicators, document years, patent countries, etc., and their trends.

Map, diagrams and matrices are interactive and dynamic.

Search history

The patent search was conducted in STN in Derwent World Patents Index database.

About 130 companies were searched by name (FiHTA members and some other existing lists of the companies in this sector) and then restricted with health-words and some ipc classes:
-health? or diagnosis? or patient or medical or pharmaceutical
-orthoped? or traumatol? or dental or retinal or blood or brain or neuro? or heart
-(retinal or dental or clinical optical or diagnostic? or medical or magnetic? resonance)(W)imaging
-(G01N0028 OR G01N0033-46-G01N0033-98 OR B01L OR A61?)/IPC

Then some phrases were searched and also restricted with the same words and classes:
genomic information; patient information system; healthcare ICT; bioinformatics or bio-informatic; genomic data management; improving life; telehealth or telecare; (bioabsorbable or bioactive or drug-releasing)(3A)(surgical implant); senior(2a)(exercise or rehabilitation); medical(2a)(application or device); personalized medicine; occupational therapy; (orthopaedic or orthosis or traumatology)(2A)use; brain stimulation; (fibre or fibre)(W)reinforcement and dental; (remote monitor?)(3a)(blood glucose); early(W)(diagnosis or prevention)(3a)gastrointestinal; blood testing; blood pressure; diagnostic(W)(solution or test)(5a)(neonatal screening); diagnostic rapid test; analytical instruments or lab? equipment or special? Diagnostic; sleep(3a)(track? or analy?); (bone index)(3a)measur?; biometric sensor; wireless(2a)(skin parameter or edema); (sensor-based or sensorbased)(W)health or health(3a)sensor; eye measuring; smart

needle; pulmonary(W)(diagnostic or monitor?); clinical neurophysiology; biosignal(3a)monitor?; (non-invasive or noninvasive)(2a)(brain stimulat?); neuro-visual test?; wireless(2a)(heart rate); safety solution(5a)(senior or elderly or patient); (heart beat or heartbeat); (medical or healthcare)(5a)(ICT or software); healthcare information; smart digital health; automatic?(3a)medicine(3a)dispens?; automatic? pharmacy service; sensor?(3a)(clothing solution); sei!ure monitor?; improv?(3a)quality(3a)life; brain disorder; digital health; virtual health; medical data storage; clinical analys?; (operational analysis or cybersecurity) and health; medical treatment system; radiotherapy or radiosurgery or X-ray tube technology; biobanking or bio-banking; smart sensor;
home care services

These 1722 documents that this search produced were analysed with the STN AnaVist visualising and analysing tool.

Important information for interpretation of the map and diagrams

1) MOST IMPORTANT PLAYERS

Key Organizations/Assignees

The organizations that have most patent publications meaning patents and patent applications.

2) PATENTING/PUBLICATION ACTIVITY

Priority Application Years

The year when the first application from the invention was filed in any office. After this the applicant has one year time to file in other countries so that also these inventions are regarded as being made on the same day.

The columns for the last 1,5 years are incomplete since patent applications filed during the previous 18 months are not public and therefore cannot be included in the report. In addition, there is a few

week's delay due to value-added texts/indexing before the publications enter the database. The columns of these years will therefore be higher when the years are full.

Patent trends are normally analysed according to the priority years – not to document years since priority application year is closer to the time when the invention was made and research was on the way.

3) GEOGRAPHICAL DISTRIBUTION OF BUSINESS AREAS

Patent Countries

Countries where patent applications have been filed for the invention. Companies try to protect their most Important geographical business areas by filing for a patent in each patent office. Indicates where the company's markets are and where it intends to profit from the invention either by using it there in production, or by importing there goods prepared using the invention, or by wanting to harass the competitors active in this country.

The analysis includes only direct filings. It does not include Designated States (those countries which have been named when a PCT or EP application has been filed).

WO: PCT, the Patent Cooperation Treaty (PCT) is an international patent filing system. It doesn't provide a "World patent" but makes it easier to file for protection for wider geographical area.

Australia is not necessarily as high on the list as it appears since it gives a national filing number at once to all PCT applications where Australia is a designated state.

4) TECHNOLOGY SUB-SECTORS

Map

The tool gathers similar patent documents into clusters. The similarity is decided on how many similar terms are used in the documents. The two words next to each cluster show the two most frequent words in documents. The closer two clusters or documents are the

more similar the contents of them are. Colours in the visualization indicate the size of the cluster, the redder the colour the bigger the cluster is (and more documents are included in the cluster).

International Patent Classification (IPC)

http://web2.wipo.int/classifications/ipc/ipcpub? Patent examiners classify the applications according to the subject area of the invention, mainly by claims. All IPC codes are taken from the family. Therefore one patent family can be included several times in the analysis.

Comprehensive and professional information sources have been used. VTT's Information Solutions does not guarantee that the results contain all public information on the subject, and does not hold any responsibility for the possible factual errors in the content of the information sources used. Patent applications filed during the previous 18 months are not public and therefore not included in the report.

Series title and number

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Title	**Finnish Digital Health and Wellness Industry** Actors, IPR Portfolio and Kalewa Ecosystem
Author(s)	Jari Ahola, Miikka Ermes, Ilkka Korhonen, Riitta Metsäkoivu & Ismo Ruohomäki
Abstract	The global health and wellness sector is one of the most progressive industries in the world, and the market is being reshaped by the emergence of new technologies and changing societal, patient and consumer demands. The Finnish health and wellness industry is currently one of the most flourishing national export business areas. The country's health and wellness sector export growth has been very positive for many years. Remarkably, export growth is based on a limited number of companies. This is one of the reasons why there is urgent need to find new growth-oriented companies and new ways to boost future growth of the healthcare sector. Relevant Finnish companies have been analysed also from the IPR point of view: a clear observation is that all the largest players in the field have a strong and active IPR portfolio as the basis for significant export share of the Finnish health tech industry. To propose for the potential Kalewa ecosystem, thorough investigation is needed to investigate the state of the art of Finnish health and wellness industry. How is the actor network constructed, who and where are the key public and private organizations and stakeholders, service providers, investors, R&D&I-organizations, accelerators, and especially the numerous technology and service companies? To summarise the analysis, the Finnish health and wellness industry ecosystem is highly complex and dynamic: it is dominated by a rather limited number of large companies responsible for a significant percentage of the total exports in the field. Further, the number of mid-size companies is very low and needs strengthening to support growth. The positive aspect is that the SMEs in the field are numerous and are very dynamically seeking new potential for product and service innovation. Due to the complex operational environment falling under the remit of several ministries, sufficient coordination of the priorities at the national level should be reached to ensure effectiveness and impact of public funding yet allowing the commercial prospects to drive the actual innovation.
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Finnish Digital Health and Wellness Industry

Actors, IPR Portfolio and Kalewa Ecosystem

The global health and wellness sector is one of the most progressive industries in the world, and the market is being reshaped by the emergence of new technologies and changing societal, patient and consumer demands.

The Finnish health and wellness industry is currently one of the most flourishing national export business areas. In addition to the analysis of industry actors, relevant Finnish companies have been analysed also from the IPR point of view: a clear observation is that all the largest players in the field have a strong and active IPR portfolio as the basis for significant export share of the Finnish health tech industry.

The Finnish health and wellness industry ecosystem is highly complex and dynamic: it is dominated by a rather limited number of large companies responsible for a significant percentage of the total exports in the field. Further, the number of mid-size companies is very low and needs strengthening to support growth. The positive aspect is that the SMEs in the field are numerous and are very dynamically seeking new potential for product and service innovation.

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