D2.3 – Reflection Paper

Related to	WP 2
Due Date	02.02.2022
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Lead Beneficiary	BioRN
Dissemination Level	Public
Revised and approved by the GA	Yes

Project Title (Acronym): Cluster excellence in Life Sciences – internationalisation of SMEs (CELIS)

GA Number: 873857

Project Executive Summary:

The current changing healthcare paradigm envisions a patient-centred health ecosystem and bottom-up medical care where also patients take an active role. Only with the involvement and contribution of new technologies, we will be able to reinvent healthcare along that pathway.

However, evidences show that the rate of health, technological and economic change and the urgency of global challenges continue to outpace Europe's response and reforms in comparison to other countries and markets. SMEs as innovation engines in health worldwide, can tackle Europe's innovation deficit, but are still faced with challenges that cannot be underestimated, and which are a hinder for translating innovation to products and services for commercial and clinical use.

Clusters, networks and business and innovation support organisations can help their cluster participants to maximize opportunities linked to cross-sectoral and inter-regional cooperation and internationalisation, by expanding relationships and by enhancing public-private partnerships. Clusters can catalyse mutual learning and facilitate access to emerging markets.

CELIS addresses these challenges by combining some of the world-class life science ecosystems in Europe, where cross-sectoral fertilisation has given rise to promising new technologies and products, resulting in new value chains.

-Clinical useful biomarkers / companion diagnostic

-High throughput -omics technologies and big-data

-Micro- and nano-electronics

- Digitalisation

CELIS clusters set up a series of actions to exploit the SME innovation engine in these crucial fields, translate ideas into applications and reduce time to market. The project will offer SMEs access to emerging markets, leverage partnerships with companies, university hospitals and researchers from different sectors and regions and increase visibility for the innovation potential of participating SMEs at European level. Simultaneously, the project will prepare, train and coach cluster staff.

Partnership:

Name	Short Name	Country
BIORN CLUSTER MANAGEMENT GMBH	BioRN	Germany
VLAAMS-BRABANT	SH Health	Belgium
DANISH LIFE SCIENCE CLUSTER	DLSC	Denmark
TARTU BT PARK OU	TBP	Estonia

Project website: https://www.health-axis.eu/celis

Life Science Cluster Rhine-Neckar

BioRN is the science and industry cluster of the Rhine-Main-Neckar region around Heidelberg, one of Germany's strongest biotech hubs. It is a non-profit network fostering health innovations and serving its members by creating a rich translational ecosystem as well as promoting, representing and connecting the regional innovation stakeholders.

Heidelberg is home to many renowned research institutes focused on genomics, proteomics and bioinformatics in the fields of cancer, cardiology, infectious disease and neuroscience.

In the surrounding region are further centers of academic excellence: the Universities of Frankfurt, Freiburg, Mainz and Tübingen, the Karlsruhe Institute of Technology (KIT) and several Fraunhofer Institutes.

Heidelberg University is Germany's oldest university and three-time winner in the federal Excellence competition.

in Heidelberg:

11 Universities & Research Institutions

5 Hospitals

>800 Research Groups

7 Nobel Prizes

Germany's **oldest** University

15000 Life Sciences Students
1 out of 5 is international

€1.1B+ budget

7 p.a. spin-off companies founded

600+ patent families filed

1984 - Founding of Technology Park

21. October 1996 BioRegion Rhein-Neckar-Dreieck e.V.

1996 - Winner of BioRegio Competition

2001 - 39 Members

2008 - Winner of Leading-Edge Cluster Competition

2010 - 89 Members

2011 - Founding of Health Axis Europe

2014 - Successful bid for the EIT KIC 'Healthy Living and Ageing: EIT Health'

2015 - Winner of Cluster Internationalization Competition

2019 - 100 Members

2021 - First German Evotec BRIDGE beLAB2122 launched in our region

2021 - Gold Label Accreditation

2022 - BioLabs-Heidelberg

For 25 years making Life Science matter...
...and Innovation happen!

BioRN is an innovation cluster based on the constant interaction between academia, industry and government for the production, transfer and application of knowledge in the Life Sciences. This approach refers to a *spiral* model of innovation, called triple-helix model.

INDUSTRY

ACADEMIA

130+ Members

GOVERNMENT
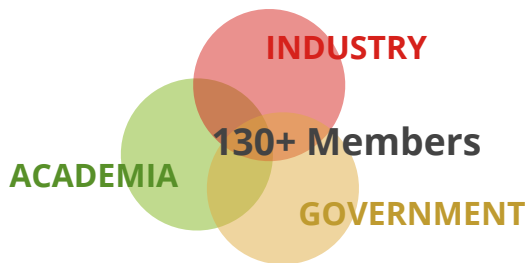
BioRN is the unique combination of all relevant innovation stakeholders in the Life Sciences around Heidelberg at the border between Baden-Württemberg, Rhineland-Palatinate and Hesse, and connected by the rivers Rhein, Main and Neckar.

BioRN counts more than *130 members*. It includes top universities, research institutions and Technology Parks. Ten global pharmaceutical companies have R&D sites or are active in the BioRN network. The ecosytem is completed by a large range of small and medium-sized enterprises as well as local government organizations and interest groups.

Members Overview
- 40% biotechnology companies either developing therapeutics, diagnostics or providing R&D services
- 25% University and Research Institutions or public and non-profit oragnisations
- 20% professional service and consulting companies spanning from legal, patents and IP to marketing, human resources and business development
- 10% Suppliers for consumables, reagents, software and packaging
- 5% are global pharmaceutical companies
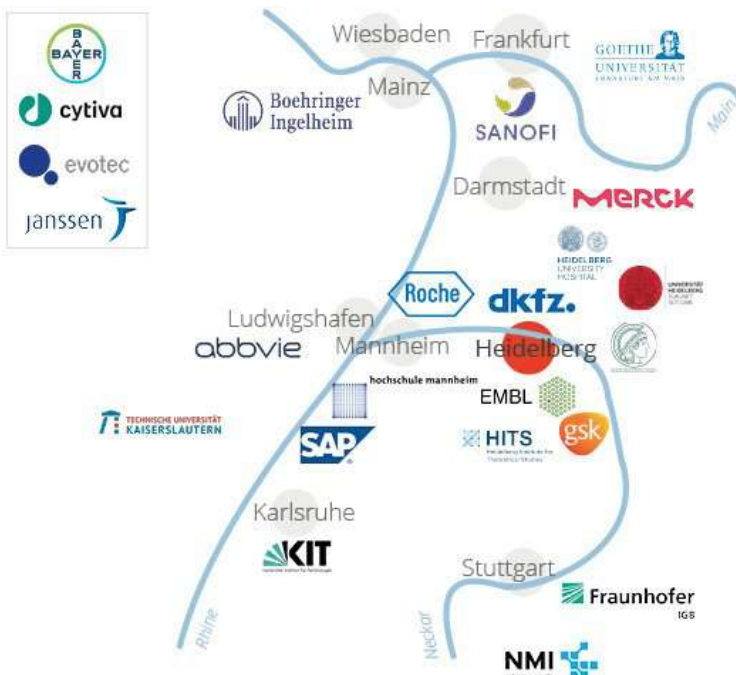
Being part of the network means investing into the development of a world-leading life science cluster, driving a rich translational ecosystem and creating innovation made in Germany

Strategy & Mission

Recent advances in biotechnology and medical biology provide many novel, promising options for treating diseases. While much of the scientific progress emerges from academic research, large biotech and pharma companies have the fundamental expertise and funding options necessary for the actual transfer of scientific results to application. As drug development productivity in the pharmaceutical industry is continuously decreasing and healthcare systems are challenged by rising costs, bringing together academia and industry to address their respective challenges is an excellent opportunity to solve issues and move forward.

The Rhine-Main-Neckar region around Heidelberg is very well suited to foster such connections as it is home to both academic excellence and strong industrial players in very close geographic proximity.

As such the region is an outstanding example of a biomedical cluster, and - because of the rich ecosystem covering the entire value creation chain and a dedicated cluster management - has seen a constant rise since the foundation of the BioRN Network more than 25 years ago.

With the vision to make life science matter and innovation happen, the cluster management established a clear strategy to become the leading European life science cluster, attracting global investment and talent. Through analysis and surveys of the ecosystem, and with input from all stakeholders this strategy is regularly updated and activities within the following four fields of action are conceived and implemented: Networking & Stakeholder Engagement; Promotion & Visibility; Cross-organizational Functions; Translational Support.
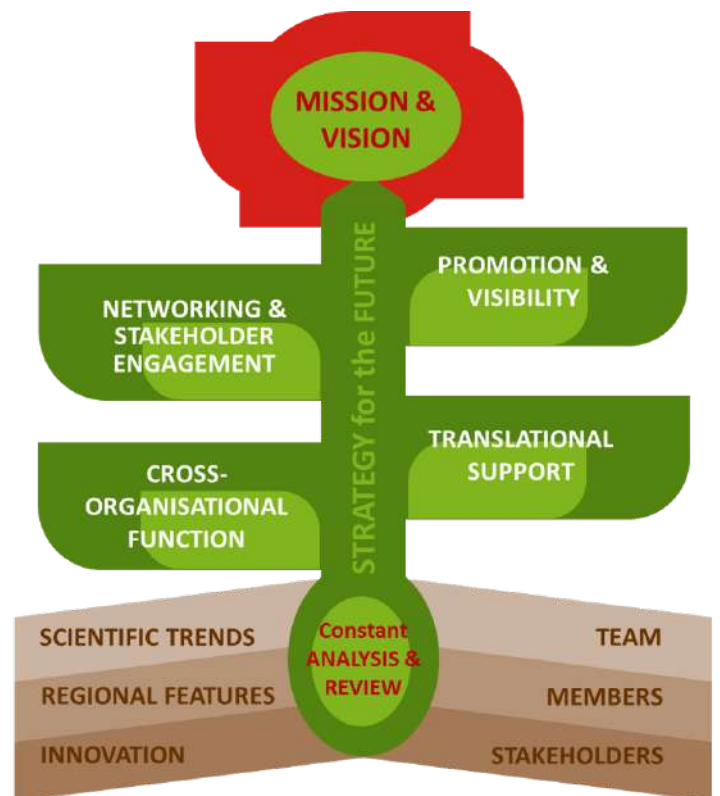
Our mission is to develop the region into a *world-leading* life science cluster attracting international investments and top global talent.

For **25** years making Life Science matter...
...and Innovation happen!

Core Activities

NETWORKING & STAKEHOLDER ENGAGEMENT

We bridge members regionally and towards other innovative ecosystems worldwide. Nurturing and extending connections among regional innovation stakeholders is at the core of BioRN's activities.

- ✅ Networking events: the BioRN Lounge is a monthly networking event centred around current scientific trends; the BioRN Espresso is the peer-to-peer event that brings a new flavour to the traditional "stammtisch". In addition regular thematic workshops are held by members and for members. >>

- ✅ Since 2009, each year the BioRN Annual Conference has been a valuable source of top information, lively discussions and networking opportunities with international experts from different fields of the life sciences. >>

- ✅ Access to an international network for joint EU application, international collaborations and best practice exchange is guaranteed through the Health Axis Europe >>

- ✅ Innovation stakeholders are represented in the BioRN boards >>

PROMOTION & VISIBILITY

We stand for the promotion and visibility of the Life Science Region at international and national level

- ✅ Public relations – Promotion and distribution of news, activities and success stories from the region and its stakeholders

- ✅ Proactive dialog with public (health) authorities to influence policies in the biotechnology and healthcare field.

- ✅ Dedicated dialog with public (health) authorities to attract funding and establish new infrastructures for the local ecosystem

- ✅ Showcasing and representing the local ecosystem and stakeholders at national and international events and professional meetings

- ✅ Attract high profile (international) events in the region (e.g. Deutsche Biotechnologietage and BIO-Europe)

**For 25 years making Life Science matter...
...and Innovation happen!**

Core Activities

CROSS-ORGANISATIONAL FUNCTION

We support inter-institutional initiatives to facilitate applied biosciences in the region.
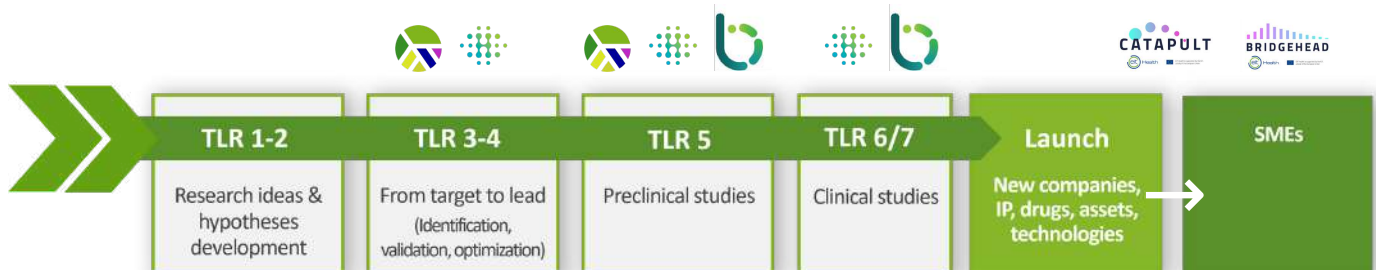
- ✅ Coordination of inter-institutional funding applications and events.

- ✅ Central point of contact for external enquiries regarding Life Science topics

- ✅ Support in identification of potential partners from SMEs, industry and academia and subsequent project management

- ✅ Different tools to efficiently match academic and early industry projects with partners from international Life Science corporates (Translation Support).

TRANSLATIONAL SUPPORT

We provide translation support, especially by leveraging the unique combination of global pharma and leading academic institutions in the region

We initiate and manage different programmes to support the development of (academic) research ideas through all necessary development stages, for therapeutics e.g. pre-clinical and clinical development, until commercialisation. Our programs are selected based on specific regional needs.

TLR 1-2	TLR 3-4	TLR 5	TLR 6/7	Launch	SMEs
Research ideas & hypotheses development	From target to lead (Identification, validation, optimization)	Preclinical studies	Clinical studies	New companies, IP, drugs, assets, technologies	

CATAPULT   BRIDGEHEAD

The translation programmes managed by BioRN can support reaserach ideas and technologies development at different stages. BioRN makes sure that those projects are reflecting specific regional needs and are complementary to further existing instruments in the region.

Core Activities

BioRN

beLAB2122

beLAB2122 is a new public-private partnership between the leading academic institutions of the Rhine-Main-Neckar region, Evotec and Bristol Myers Squibb to identify, fund and execute novel disease modifying therapeutic projects with the goal to develop these to new spinout companies.

https://belab2122.org/

biolabs Heidelberg

BioRN is initiator, project manager and Founding Partner of Biolabs Heidelberg. As part of the global BioLabs membership-based network of co-working space for startups, BioLabs will offer premium on demand wet laboratories and office spaces to early-stage life-science startups with direct access to a network of industry parters and investors. The staged opening is planned from December 2021 to early 2022.

https://www.biolabs.io/

BioRN Scout

Custom-fit search and care-free match to enable innovation. The BioRN Scout partnering programme joins major regional and European networks to effectively match health care innovation seekers with innovators.

https://www.biorn.org/scouting

CATAPULT
eit Health

A training and competition programme to award the best business concepts from medtech, biotech, and digital health in EU

https://eithealth.eu/catapult/

BRIDGEHEAD
eit Health

Enabling mature foreign start-ups to expand their business into our regional / national market

https://eithealth.eu/bridgehead/

Regional lighthouse stories

Apogenix A German Cancer Centre (DKFZ) spin-off company founded 2005, focus on immuno-oncology therapeutics. Licensing agreement with AbbVie in 2014.

Bayer HealthCare and DKFZ Strategic alliance against Cancer. This collaboration aims at finding and exploiting molecules, mechanisms and models for anticancer therapies. The collaboration has invested more than 10 million Euros for oncology research.

BioMed X Institute academia/ industry collaboration model. Scientists work jointly on pre-clinical research projects sponsored by corporate partner. Total project volume € 31 million. Sponsors include Merck, AbbVie, Boehringer Ingelheim and Roche.

Cellzome An EMBL spin-off company focused on chemoproteomics; acquired by GSK in 2012; Expansion of site on EMBL Campus.

EMBL Open Targets shared initiative by EMBL-EBI, GSK, Sanofi, BMS, Takeda and Wellcome Sanger Institute to generate evidence on the validity of therapeutic targets based on genome-scale experiments and analysis.

InoCard Cardiology gene therapy technology developed by Prof. Most and Prof. Catus (University Hospital Heidelberg). Acquired by UniQure in 2014, where founders became directors of UniQure Germany.

MYR Pharmaceutical HEPCLUDEX, the first approved drug for the treatment of chronic hepatitis D, is based on Prof. Stephan Urban's research at the University Hospital Heidelberg. The drug was launched successfully in September 2020 by MYR, that was acquired in 2021 by Gilead for 1.45 billion euros.

MTM Early diagnosis of cervical cancer developed by Prof. von Knebel Doeberitz (University Hospital Heidelberg). Sold to Roche.

Phenex Pharmaceuticals is a privately owned drug R&D company, founded in 2002, focusing on small-molecule drug discovery in liver diseases and in cancer. One discovery programme was acquired for $ 470 million from Gilead.
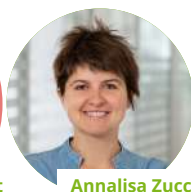
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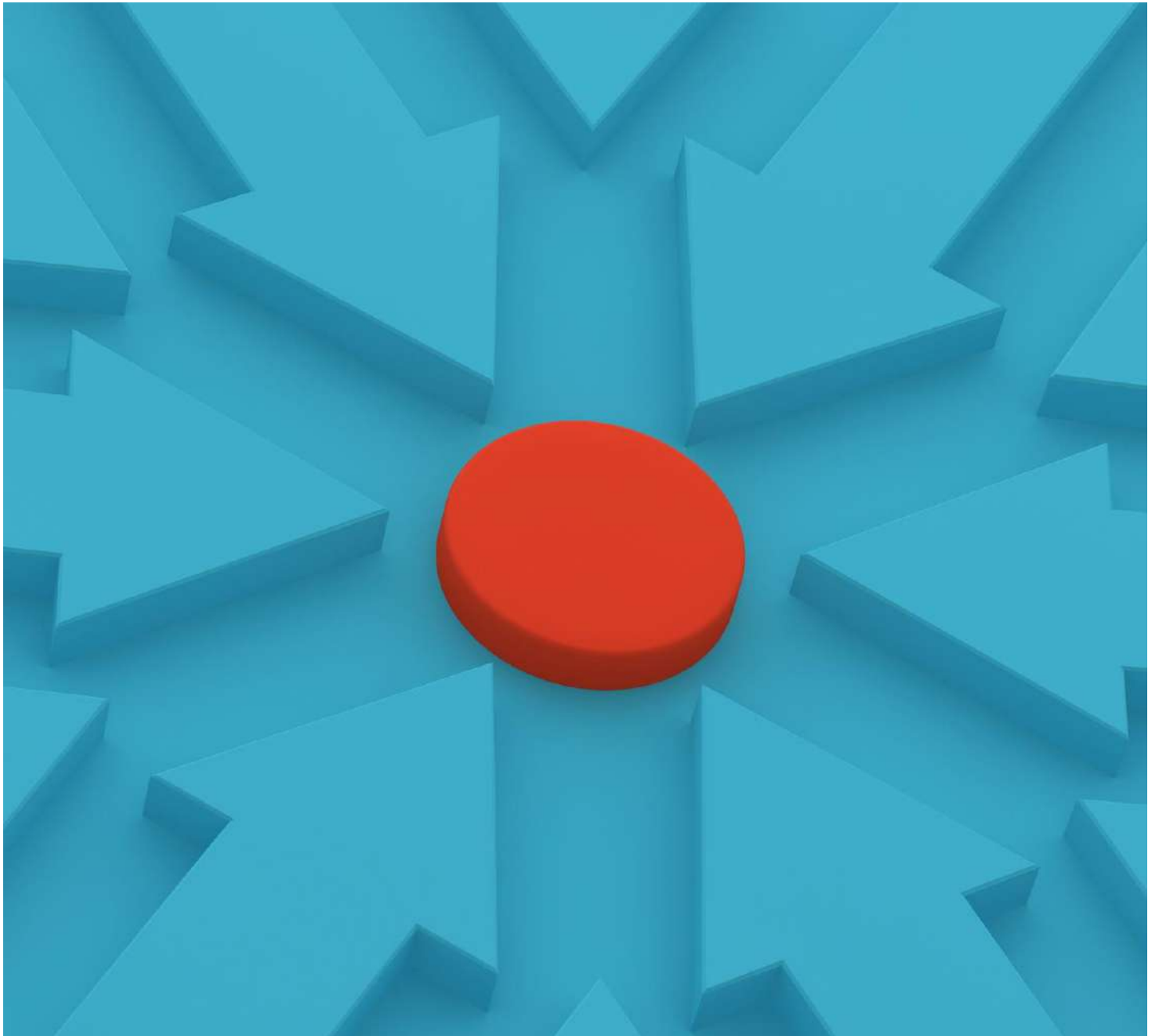69120 Heidelberg, Germany

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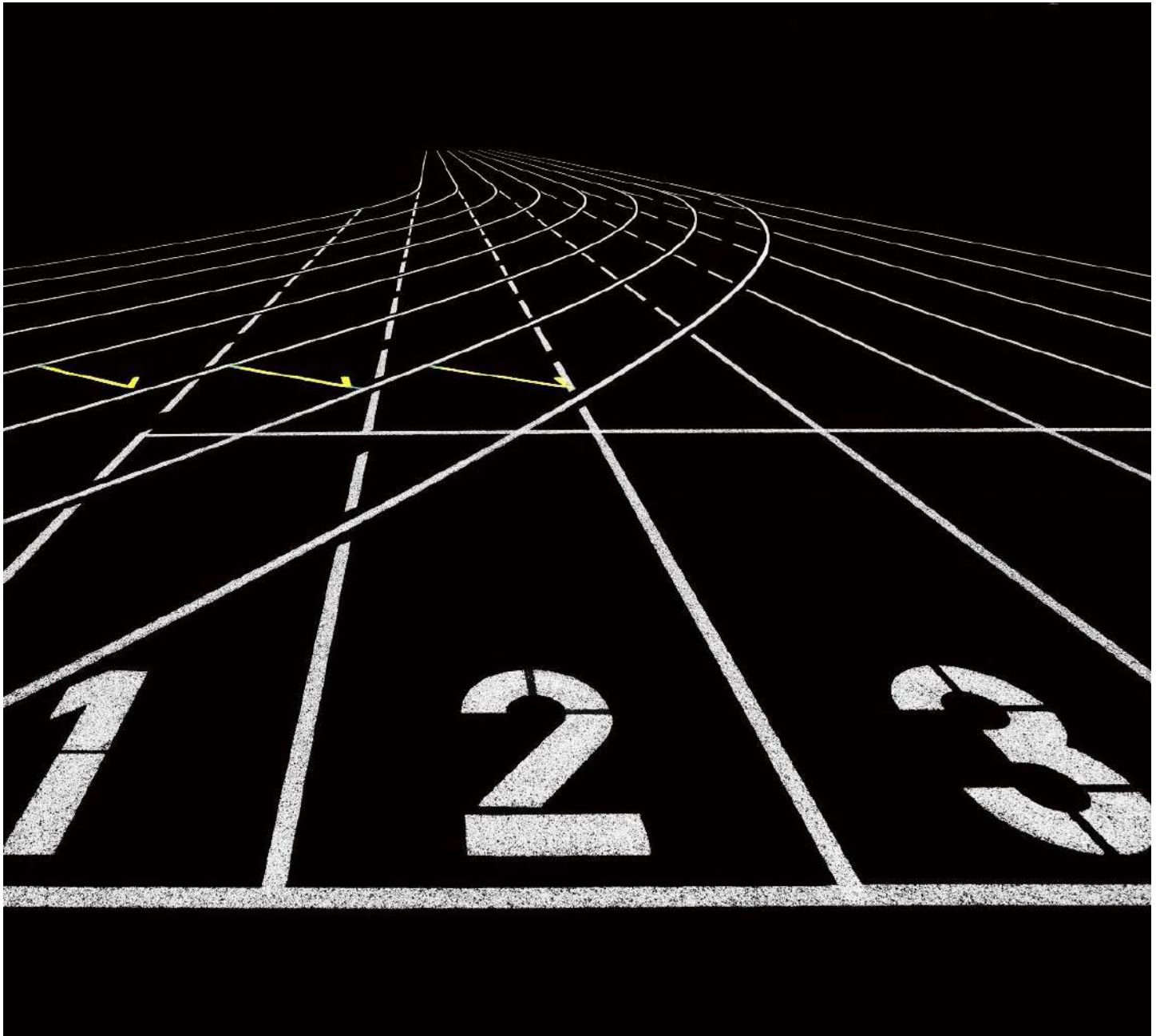
...and Innovation happen!

SUPPORTING THE
MICRO AND NANO ELECTRONICS FOR
HEALTHCARE ECOYSTEM
WHITE PAPER

SEIZING MARKET OPPORTUNITIES

An important part of the Flemish companies that are active on the cross-over between micro and nanoelectronics and health, are reached by Smart Hub Health and its partners in the Flemish ecosystem. How can Smart Hub Health support these companies most efficiently in seizing the considerable market opportunities in their field? This white paper summarizes the lessons learnt in that regard from the project Cluster Excellence in Life Sciences – Internationalisation of SMEs (CELIS).

MARKET INSIGHTS

Focused internationalisation

As described in the CELIS (*) - Report 'Market insights regarding micro and nano electronics for healthcare in Flanders-Belgium' more than 100 companies in Flanders are active on the cross-over between micro and nanoelectronics and health. Looking at the major trends in health care applications and knowing that micro and nanoelectronics are one of the major enabling technologies to realise those trends, splendid opportunities are arising worldwide. The market insights report points out that because of its small size, the presence of mainly SMEs and a lack of large integrators, internationalisation is even more important for the micro and nanoelectronics industry in Flemish Brabant and Flanders than it is in other countries.

Market data suggest that for medical applications, a clear focus on specific countries is advisable. The US market is number one, both for its market size and the level of innovation going on. Considering growth, the Asia-Pacific region with countries like China, Japan, India, Taiwan, South Korea and Singapore is certainly equally important for our micro and nanoelectronics industry. In Europe, the countries with the largest expenditure on healthcare are Germany, France, the UK and Italy. Taking into account the employment rate in the medical industry per inhabitant, Ireland, Switzerland and Denmark are further interesting countries.

Smart Hub Health is already playing a supportive role in this respect, but much more can be done. Internationalisation is an important element in clusters activities and services carried out by most cluster organisations. It is also linked to other cluster activities such as improving innovation capabilities, exploring business opportunities, education and training, marketing and branding. Smart Hub Health needs to understand in which fields it can do more and where it can support its partners to cater better for the needs of the regional health industry.

THE ROLE OF SMART HUB HEALTH

Life on Chip

Smart Hub Health's flagship event is the Life on Chip conference, dealing with the cross-overs between micro and nanoelectronics and health. With this yearly event, Smart Hub Health reaches most of its ecosystem. The conference focuses on innovation, networking and internationalisation.

💡 Life on Chip primarily needs to strengthen its international outreach

➡ After very positive results in 2021, the event needs to be organised as a hybrid event in the coming years, allowing more international speakers and participation of a worldwide audience

➡ The event can be co-organised with some strong international partners.

Improving framework conditions

The Flemish region is the first and foremost actor to improve framework conditions for researchers and entrepreneurs in health and technology field. However, Smart Hub Health can convince its main shareholder, the province of Flemish Brabant, to play an additional role in some fields

💡 The Province of Flemish Brabant should improve selected framework conditions

➡ The Province of Flemish Brabant can develop general policy advice and suggestions for concrete actions in the fields of attracting talent, support of start-ups, development of research infrastructure,

New services to be explored and developed

Apart from - limited - activities in the fields of support of innovation, internationalisation, networking, training and funding, Smart Hub Health relies on close cooperation with other partners to strengthen the health and technology ecosystem in Flemish Brabant. Its most important cluster partners are DSP Valley, MedTech Flanders and Flanders Bio, who are in this specific field cooperating in the new spearhead cluster flanders.healthTech. Consequently, Smart Hub Health is well advised to support the new spearhead cluster in becoming more performant

💡 Smart Hub Health should support flanders.healthTech in developing the full range of services, focusing on fields where it can have an added value

➡ Smart Hub Health can support flanders.healthTech in scouting for partnering and investment via financial support and facilitating international scouting via contacts with partners in Germany, The Netherlands, Denmark and Sweden. See entry under flanders.healthTech

THE ROLE OF FLANDERS.HEALTHTECH

The services provided by the spearhead cluster flanders.healthTech are structured at four levels: "inform", "connect", "cultivate" and "carry". Services include informing members about general healthtech developments, innovation roadmaps and business opportunities, organising events, networking sessions and thematic working groups, organise training courses and seminars, and facilitating access to innovation funding. For the cultivate and carry levels, a personalised service level trough an account manager is added.

As flanders.healthTech is a young cluster, most services are still being developed. For the cluster to really thrive, new services might be added.

Strengthened or additional services that can be considered are:

* creation of companies trough start-up support and/or the establishment of an incubator

* facilitating access to equity financing

* supporting internationalisation; connecting members to global value chains and international investors

* facilitating access to talent

* facilitating access to of creation of new joint research infrastructure

* tailored scouting for innovation seeking companies: identification of industry partners (for partnering, investment and licensing needs) and identification of academic collaboration opportunities among academia, start-ups and medium-sized companies (based on the BioRN Scout scheme - https://www.biorn.org/scouting)

* Creation of specific networks around concrete topics to foster triple helix cooperation (industry, academia, government). Possible partners are (academic) research units, incubators, investors, hospitals, life science industry and Flemish authorities.

* Development of a flanders.healthTech Portfolio, maintaining, updating and activating key data about innovative projects generated from academia, hospitals and startups in life sciences and healthtech. (based on the BioCat BioRegion Portfolio - https://www.biocat.cat/en/about-bioregion/bioregion-directory)

THE ROLE OF THE CELIS-CONSORTIUM

The CELIS project provided a good opportunity for the participating clusters to expand their European network and to learn from each other. The CELIS partners will continue to pursue cooperation and will broaden their partnership where relevant. Cooperation can either happen in an informal way or through new funded projects.

➡Smart Hub Health will initiate or contribute to joint European project development with other CELIS partners. Where appropriate, flanders.healthTech will be put forward as the partner for Flanders.

➡Smart Hub Health will continue periodic informal exchanges with the CELIS partners

➡Smart Hub Health will seek the participation of speakers and participants from the CELIS partners for future events such as Life on Chip.

(*) In CELIS, four life science ecosystems in Europe cooperate in order to better support SMEs that are active in the fields of biomarkers/companion diagnostics, multi-omics technologies, micro- and nano-electronics and digitalisation. The CELIS project offers SMEs access to emerging markets, leverages transnational partnerships with companies, university hospitals and researchers and showcases the innovation potential of participating SMEs on a European level. Simultaneously, the project is preparing, training and coaching cluster staff.

CELIS is funded by the European Union's COSME Programme (GA No.: 873857)

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"Digitalisation in Healthcare: Growing the future"

Emerging Technology White Paper

Tartu
2021

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Introduction

When Covid-19 hit the world, medics working in pretty much every healthcare system wished they were just a little bit more…Estonian.

While doctors found themselves adapting to a whole new way of giving consultations within weeks, and pharmacists were searching for a way to prevent vulnerable people queuing outside their stores to pick up their weekly medications, in Estonia, it was business as (sort-of) normal.

Estonia's health service has been digital for 12 years. More than 99% of the data generated by hospitals and doctors is digitised. Citizens can access their own medical records via a super-secure online portal and choose who gets to look at those records. That means finding out whether or not you've had a jab for yellow fever is a few clicks away, as is discovering just how many millilitres of a particular drug you were given when you had your tonsils taken out.

Many health services also happen online — from video consultations to e-prescriptions. And things that can be enormously complicated elsewhere, like registering a death and notifying all the relevant parties, are seriously simple; in Estonia, once death is registered online, notifications are automatically sent to that person's workplace, the tax office and the population registry.

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TARTU BIOTECHNOLOGY PARK
integrated expertise

3

CELIS is funded by the European Union's COSME
Programme (GA No.: 873857)

PART 1 Digitalisation in Healthcare

Visionary Seminar: Visions that may shape the future!

On this premise, the project CELIS brings the visionary seminar to share and guide through all the stages of digitalisation and offer an ecosystem, both in-person and online, to learn from the industry leaders. The hybrid seminar had a focus on the potential and possibilities within the subject "Digitalisation in Life Sciences" – initiating digital transformation and change management in the health sector, trying to foresee the next 5-10 years of development in the field.

The visionary seminar was divided into two sessions, first presenting different healthcare sector innovations, proven to be successful from Estonia and the second part consisted of innovative presentations about the future of Healthcare.

Let's see what are those things that the world can learn from visionaries to become more digitally advanced in healthcare.

Strong cyber security and trust are the foundations of a digital health enabled society

Dr Ain Aaviksoo, who is the Chief Medical Officer of Guardtime Health, MD from the University of Tartu and MPH from Harvard University, talked about the superior approach to public challenges of digitising healthcare. According to him, the secure exchange of data is the most important thing that needs to be kept in mind.

If we start from a situation, when all our data is digital because it is created digitally in the first place and put that data to use in a way that we can prove the time integrity or the provenance of that data in the future, a country can build such a solution, where nearly everything is possible digitally.

Dr Ain also shared that since healthcare is happening in many places at the same time, simultaneously, so there needs to be a way to make the single version of the truth/data available to everyone. Hence the universal conceptual model of healthcare solutions being built should be based on data security, data privacy, and very importantly have the integrity of processes. Cybersecurity compliance audit and reconciliation, trusted third parties, are just old and clumsy ways that are built on the analog and of paper world. Whereas in the digital world, where things happen instantaneously, very flexibly, we need to have a technology that supports just this process integrity in its own way.

The very practical example that he shared was that we see a lot of traction now in healthcare is that instead of building huge data lakes, which has been the quest maybe for last 10 years, people

are now turning to build a reliable platform that can utilise these data lakes and analyse and harness the power of data to convey a meaningful outcome. To build such a platform, first, you secure the data in the original location in a way to maintain its integrity so that you can trust in future that the information is reliable. And then using multi-party computation, automate the auditing of that. So that if now this aggregate is used to track those deals, and the results, the single version of the truth is shown to all the stakeholders

Lastly, sharing his dream, Dr Ain shared some of the possible areas where there is scope for innovation. Some of them being, more real-time healthcare in future, value-based payment systems, there would be personalized decision making driven by the data, there is real evidence used all the time, health services are business invisible and are an integral part, and frictionless governance across borders.

At the time of writing this report, WHO has announced an international partnership to build a trusted COVID-19 Vaccination Certification Infrastructure along with the Estonian Prime Minister[1]. It seems that the vision shared by Dr Ain is already being realised by him in addressing the need of the hour, i.e. the global vaccination drive and the evidence of the same!

Biobanks will enable the next era of innovation in healthcare!

Prof Tõnu Esko shared his lessons from Estonian Biobank and threw more light on the rise of precision medicine. He is the Vice Director of Development and head of Estonian Biobank Innovation Center at Institute of Genomics, University of Tartu, where he holds Professor Human Genomics position genomics. Tõnu Esko is also a Research Scientist at the Broad Institute of Harvard and MIT, Cambridge, USA and visiting researcher at the Children's Hospital Boston and Harvard Medical School, Boston, USA.

He gave us an introduction about how genetics and big data when combined with genetic factors could really lead to new and effective medicine and treatments.

Tõnu started by highlighting the importance of both genetic and lifestyle risk factors in the risk of developing certain diseases. Emphasizing that it's important to know one's genetic background to be able to modify the lifestyle because the more genetic risk one has for a certain disease, the less flexibility one has in his lifestyle choices.

The 21st-century citizen-centred state and service-oriented society require information systems to function as an integrated whole to support citizens and organisations. There must be interoperability between different organisations and information systems. In other words, they must be able to work together, and data needs to be requested from the citizen only once.

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[1] https://guardtime.com/blog/who-digital-covid-19-vaccination-infrastructure

The Estonian Biobank (EBB) is a population-based biobank of the Estonian Genome Center at the University of Tartu (EGCUT. Its cohort size is currently close to 200,000 participants ("gene donors" ≥ 18 years of age), which closely reflects the age, sex and geographical distribution of the Estonian population.

Estonians represent 83%, Russians 14%, and other nationalities 3% of all participants.

Genomic GWAS analyses have been performed on all gene donors, and RNA samples from 2,100 individuals are available for gene expression studies, along with 45 biomarkers from serum and plasma.

https://www.eithealth-scandinavia.eu/biobanks/the-estonian-biobank/

The unique thing about the Estonian biobank is that it's the first biobank that had its own biobanking law, to support nationwide research projects. It doesn't just regulate how the data is used, and what are the rights and obligations for the database custodians, but more importantly, it gives the participants a lot of rights and protections against discrimination and misuse of their genetic information.

When people join the biobank, they sign a broadly informed consent. In this proof, broad informed consent, they give the rights to the biobank to contact them, to invite them to be part of further research studies, and also to actually connect with this extra information infrastructure to retrieve health information like all the hospitals, health records, registries, prescription databases, all that is related to the individual and it also gives the participants the right to know.

Estonia, indeed is one of the forerunners, getting such a big part of the population genetically profiled. Not just profiled but also to open that data for research, for clinical work, for the benefit of the participants.

According to Tõnu Esko, the future of medicine is definitely genetic medicine and it makes sense to keep an eye on different developments or come up with tools and services to make good use of genetics in providing better care for the patients.

Five main parameters to see if your country is ready for personalised medicine:

- Availability of e-health, EMR and other e-infrastructure
- Availability of advanced Genome analysis technology
- Availability of scientific and medical expertise
- Identification of genomic variations with effects on human health and behaviour
- People's interest in the adoption of personalised healthcare

Being open advances society

2020 is the most surprising year in quite a lot of aspects. And as we know, we are all confronted with a crisis, all people around the globe are opening up doors and breaking down walls for global collaboration. This helps in opening up data to create models that allow us to predict more specific concepts.

During the first covid crisis, within only eight weeks, Europe was able to collect a group of over 100,000 people that worked in 42 countries, that created over 25 million of pieces of open source development medical supplies by using digital manufacturing capacities, makerspaces, 3d printing, injection molding, all kinds of technologies were in use that was never seen before. In fact, the U.S. Food and Drug Administration (FDA) also came up and approved some of these designs that the community created and they were liberated for clinical use, all in less than two months.

Bart de Witte, one of Europe's leading and awarded experts on the digital transformation of healthcare, and one of the most progressive forward thinkers focused on finding alternative European strategies for the current postmodern world to create a more desirable future with greater social benefits, shared some points, Do's and Don'ts, to take into consideration while building resilient digital healthcare ecosystems:

- The biggest hack is to give everybody access to health care. There should be open source AI in healthcare because if we open-source AI, we get a lot of companies like the libraries on GitHub that can start using and adopting. And we don't get monopolized or colonized by big tech companies that are entering the market.
- Lowering down the barriers to getting access to the technology would create more business, hence experience economy would be the next phase of economical value creation in healthcare.

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- When one develops a digital future in healthcare, one should ask himself, what workflow should it follow? Should it follow Moore's or Eroom's law for the digital age?
- In digital healthcare, one should compete on experience and not compete on IP.
- Information asymmetries will always lead to inequality. When we think about AI, we create asymmetries, asymmetries between larger organizations, private organizations and individuals. In Europe, they had asymmetries between the medical substances that you need to produce drugs because they were all produced in another country, hence removing asymmetries and building resilience and sovereignty as an answer is really important.
- When we think about algorithms and business models, there is one single company that decides in Europe. But in healthcare, Europe has billions of EU funding on research to try to avoid this and recreate its search engine for Europe. And then they started investing in research alone is not the thing, it is the business model. It is the platform, it is the network effect. So there is much more than just having IP.
- The value system should be based on inclusivity, humanity should be the beneficiary and not the shareholders
- The AI model being built should be based on the fundamental rights, like the right of integrity of a person, that means it should take into consideration things like informed consent, privacy prohibition etc.

Don'ts

End up in a monopoly of medical knowledge and creating symmetries. This can be avoided by stopping seeing data as a commodity, as the new oil, or gold. The data in healthcare is something that is extracted out of an individual's body and belongs to a society or belongs to the individual, there is no legal definition on who owns data, there is a gray zone in there.

Creating AI of the people, by the people and for the people

Hippo AI vision is an NGO, a humanitarian nonprofit that wants to accelerate the open development of AI. They believe that AI should be accessible to the general public, free of economical interest. And want to serve humanity, regardless of race, religion, gender, sexual orientation, creed, or political affiliation for any disease.

The foundation collects donations to build global Data Commons for AI, publish the data under an Open Knowledge license, that at the end, accelerates medical discoveries that are available to all.

They partner with one single patient with a specific disease, this patient becomes the face and donates name and the data and the face for advocating for the campaign. All the patients that are suffering from the same disease, can donate money or health data. And then they create these global data sets that are available to all under the license and hence,

- Creating data and AI commons like AI is a common good.
- Avoid information asymmetries,
- Protect human rights,
- Solve the United Nations Sustainable Development Goals
- Create a movement driven by people, patients that want to democratize AI.
- Create a public awareness
- Accelerate data donation, and
- Accelerate collaboration

Expanding the potential of digitalization going from e-health to *in-silico*

Dr Liesbet Geris, who is Colleen-Francqui Research Professor in Biomechanics and Computational Tissue Engineering at the University of Liège and Leuven in Belgium, also is currently the executive director of the Virtual Physiological Human Institute

A European initiative, the Virtual Physiological Human (VPH), is focused on a methodological and technological framework that enables collaborative investigation of the human body as a single complex system. The collective framework makes it possible to share resources and observations formed by institutions and organizations, creating disparate but integrated computer models of the mechanical, physical and biochemical functions of a living human body.

Dr. Leisbet Geris told that Virtual Physiological Human leads to a better healthcare system which aims to produce the following benefits:

- personalized care solutions
- reduced need for experiments on animals
- more holistic approaches to medicine
- preventative approaches to the treatment of disease
- The use of in silico (by computer simulation) modelling and testing of drugs could also reduce the need for experiments on animals.

VPH is a framework which aims to be descriptive, integrative and predictive.

The framework is formed by large collections of anatomical, physiological, and pathological data stored in digital format, typically by predictive simulations developed from these collections and by services intended to support researchers in the creation and maintenance of these models, as well as in the creation of end-user technologies to be used in the clinical practice.

The VPH model aims to integrate physiological processes across different length and time scales (multi-scale modelling). These models make possible the combination of patient-specific data with

population-based representations. The objective is to develop a systemic approach which avoids a reductionist approach and seeks not to subdivide biological systems in any particular way by dimensional scale (body, organ, tissue, cells, molecules), by scientific discipline (biology, physiology, biophysics, biochemistry, molecular biology, bioengineering) or anatomical sub-system (cardiovascular, musculoskeletal, gastrointestinal, etc.).

Personalized care solutions are a key aim of the VPH, with new modelling environments for predictive, individualized healthcare to result in better patient safety and drug efficacy. It could also result in healthcare improvement through a greater understanding of pathophysiological processes. The use of biomedical data from a patient to simulate potential treatments and outcomes could prevent the patient from experiencing unnecessary or ineffective treatments.

Summary by the moderator

Hope

The moderator, Mr Sachin Gaur, showed a common theme across the four speakers which were data in the healthcare domain. While Ain emphasized the aspects linked with data security and protection to improve reliability, Tõnu emphasised on precision which comes from biobanking or 'omics' data. Bart talked about keeping the access to that data equitable so that there is equity of larger society in this AI-led healthcare movement. Liesbet aced it up by showing how the data models can enable faster turnaround time in clinical trials, simulation of complex therapies and procedures and making healthcare safer and more sustainable. She summed it up by saying that the most important 'omics' is economics!

He further highlighted some points accentuated by the current covid crisis, which demands the world to prepare a large scale digital enabled role out of covid vaccine, taking inspiration from nature ('dogs detecting covid patients' and success of small startup bluedot in predicting covid-19 outbreak) and how new pandemic tracking approaches need to be developed for building resilience before the next pandemic strikes.

Barriers

Experts from large countries often dismiss the Estonian version or any other futuristic society as a nice, controlled environment. What we can definitely draw as a lesson from a technology-led future that technology, while is a key building block for bringing this more equitable, accessible and safe future but it is not sufficient. Where most societies lack is the political will for changing the status quo, which in turn comes from the societal readiness of adopting and asking for the change.

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We often miss out on these important human factors to bring change. Mere looking at the future from a technology lens could be a wish list but not reality. Bringing societal stakeholders together, a bottom-up movement that empowers users is the real driver of change in societies like Estonia! This is the most difficult part to replicate compared to a technology led digital solution.

Conclusion

Digital in healthcare is the biggest opportunity which is further accelerated by COVID-19; it increases the access, whether it is rural or urban, the access remains the same. In the past few years, the world has seen tremendous innovation in digital health technologies, including the electronic health record, virtual visits, mobile health, wearable technology, digital therapeutics, artificial intelligence and machine learning. The increased availability of these technologies offers opportunities for improving access, outcomes, adherence and research.

Digital Health is a precursor to preventative healthcare. It is a proactive approach to healthcare and promotes long term sustainability. As monitoring of health data using digital health provides a framework to predict health episodes in advance. hence, It focuses on preventing or detecting health issues before they evolve into major medical problems. Transforming healthcare with digital as the key pillar will enable a more sustainable future for Europe and other societies.

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PART 2 Estonian e-Health Ecosystem

Major players supporting the field or working on the field of digitalisation in healthcare

Health Clusters

Connected Health Cluster, founded by the <u>Science Park Tehnopol</u>, is a country-wide partnership between health-related stakeholders in Estonia, who are committed to accelerating the adoption of connected health solutions, on an international scale and on commercial terms[2].

Science Park Tehnopol is a research and business campus helping to develop startups and SMEs more quickly. Tehnopol Startup Incubator helps technology-based startups to develop their business and get investments.[3]

Tartu Health Cluster, founded by Tartu Biotechnology Park, is for life science and biotechnology companies and other stakeholders on Tartu City, Southern-Estonian and Estonian level, alleviating the Estonian biotechnology sector bottlenecks by connecting local industry with potential partners abroad through their network, helping local companies thrive through providing access to conferences, trade fairs and exhibitions and providing joint marketing for Estonian companies in events and webinars[4].

Tartu Biotechnology Park provides physical infrastructure as well as business development and consultancy services to companies and R&D institutions in the fields of biotechnology, medicine and veterinary medicine[5].

Medicine Estonia Cluster joins medical institutions interested in export of medicine by attracting patients from abroad.[6]

Health Founders is a vertical health technology accelerator in the Baltics. Helping exceptional founders develop breakthrough ideas into sustainable business models.[7]

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[2] https://www.connectedhealth.ee/,accessed 24.08.2020

[3] https://www.tehnopol.ee/en/startup-incubator/, accessed 24.08.2020

[4] https://biopark.ee/tartu-biotechnology-cluster?lang=en,accessed 24.08.2020

[5] https://biopark.ee/?lang=en,accessed 24.08.2020

[6] https://biopark.ee/?lang=en,accessed 24.08.2020

[7] https://healthfounders.ee/, accessed 14.09.2020

Roles of governmental institutions in digitalisation of Estonian healthcare

The Ministry of Social Affairs plans the health care policy and organises its implementation. The objective of the Ministry of Social Affairs, together with relevant institutions, is to ensure the following through health policy:

- the availability, quality, and safety of healthcare;
- the awareness of and satisfaction with health services among residents.[8]

TEHIK (Centre for Health and Welfare Information Systems) is a competence centre of information and communication technologies in healthcare, social protection and social work fields[9].

Information System Authority enables and secures all the e-solutions[10].

Research/Academia

Estonia has altogether 26 educational institutions offering higher education.

The leading university with a highest reputation offering master and degree programmes focused on healthcare is the **University of Tartu**. Several masters programmes are provided by **Tartu Health Care College** and **Tallinn Health Care College**. Various courses related to digitalisation of healthcare are provided by some other universities like **Tallinn University** and **Tallinn University of Technology**.

Next to the universities several research institutions are established. **University of Tartu Institute of Genomics** gathers - Estonian Biocentre, Estonian Genome Centre and Core Facility. The University of Tartu, Institute of Genomics Core Facility is dedicated to providing genotyping and sequencing services to researchers, clinicians and others with the state-of-the-art technology of Illumina.

Estonian Biobank is a population-based biobank of the Estonian Genome Center at the University of Tartu. The cohort size is currently 200.000 gene donors (20% of ≥18 years of age population), which closely reflects the age, sex and geographical distribution of the Estonian population.[11]

Also, the **Institute of Clinical Medicine** is created at the University of Tartu.

[8] https://www.sm.ee/en/e-health, accessed 26.08.2020

[9] https://www.tehik.ee/, accessed 26.08.2020

[10] https://www.ria.ee/sites/default/files/content-editors/ria_aastaraamat_2020_48lk_eng.pdf,accessed 24.08.2020

[11] https://ccht.ee/home/, accessed 27.08.2020

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The main task of the institute is to conduct teaching, research and development activities in its disciplines and related disciplines. Most of the clinical subjects of the Medicine programme are taught at the Institute of Clinical Medicine. The institute is the main coordinator of the residency (postgraduate specialist medical) training, the clinical medicine doctoral (PhD) studies and the doctors' continuing education at the University of Tartu and in Estonia. Most of the academic staff are clinicians, who hold different positions at the Tartu University Hospital.[12]

Research and development units are found in all biggest hospitals in Estonia.

The Tartu University Hospital is the main clinical research institution in the country.

The North Estonia Medical Centre is another top healthcare provider in the country. Research and Development department gives opportunity to organise science, training, and development activities[13].

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[12] https://kliinilinemeditsiin.ut.ee/en, accessed 12.09.2020
[13] https://www.regionaalhaigla.ee/et/teadus-ja-arendustegevus, accessed 27.08.2020

X-road - Estonian e-solution environment

X-Road® software-based solution X-tee is the backbone of e-Estonia. It allows the nation's various public and private sector e-service information systems to link up and function in harmony.

Estonia's e-solution environment includes a full range of services for the general public, and since each service has its own information system, they all use X-tee. To ensure secure transfers, all outgoing data is digitally signed and encrypted, and all incoming data is authenticated and logged.
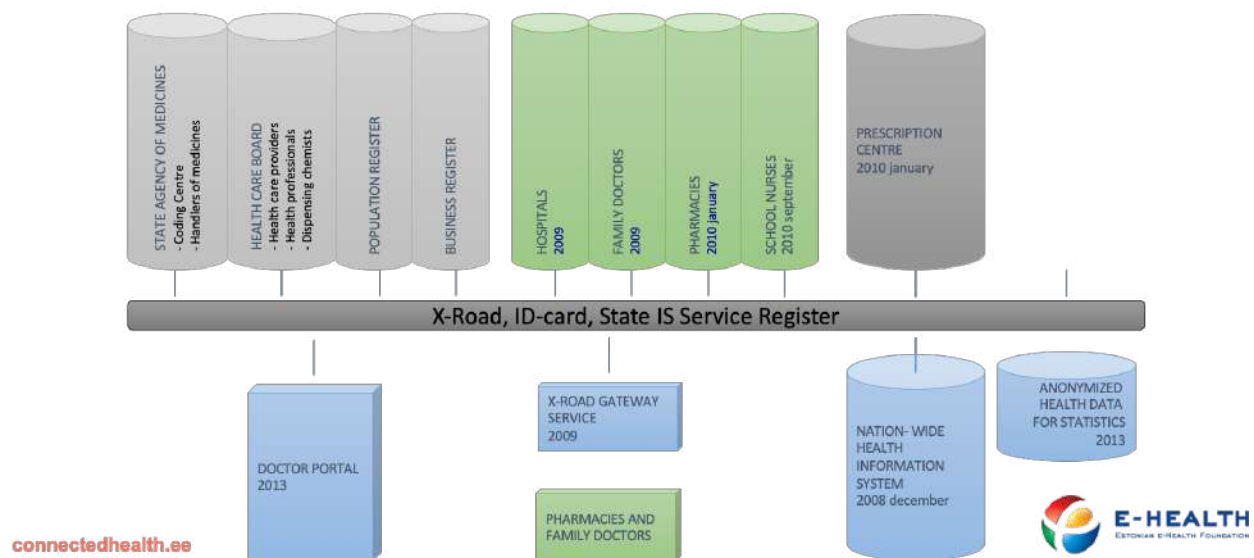
It connects different information systems that may include a variety of services. It has developed into a tool that can also write to multiple information systems, transmit large data sets and perform searches across

several information systems simultaneously. X-Road® software based Estonian environment X-tee was designed so it can be scaled up as new e-services and new platforms come online.

Today, it is implemented in Finland, Kyrgyzstan, Faroe Islands, Iceland, Japan, and other countries. Similar technology that is based on the Estonian interoperability experiences has also been implemented in Ukraine and Namibia.

Two X-Road® ecosystems can be also joined together, federated as a one-to-one relationship between two ecosystems. Members of the federated ecosystems can publish and consume services

with each other as if they were members of the same ecosystem. Federation enables easy and secure cross-border data exchange between these ecosystems. [14]

Estonia and Finland are the first two nations in Europe to develop a joint data exchange platform based on Estonia's X-Road in 2018, which allows databases in both countries to interface, assist with cross-border services, and make e-services accessible to Estonian and Finnish citizens.[15] According to Estonian Ministry of Social affairs there are changes planned to involve more private enterprises to development of healthcare.

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[14] https://e-estonia.com/solutions/interoperability-services/x-road/, accessed 14.09.2020
[15] https://e-estonia.com/x-road-between-finland-and-estonia/, accessed 24.08.2020

Summary from Estonian Health Experts opinions

Estonian e-health system is among leading countries globally with a number of advanced e-health applications like e-prescription, e-consultation, e-health records in hospitals and digital health history of patients. Estonia has 4 major health databases on which are based different services - Estonian nation-wide Health Information System, Estonian Health Insurance Fund's database, Estonian Bank of Healthcare Images and Estonian Genome Bank. Estonian Genome Bank has restricted access through individual request by the participants, but the other three are accessible by health professionals. The government is in the process to develop a platform for managing informed consent by data subjects that can digitally give consent on their health to secondary data users incl. private companies.

Nevertheless, there are some challenges in Estonian healthcare digitalisation that experts pointed out.

Data Usage and Management

Data is kept in different databases and the interactions between those databases is not always sufficient and reliable. There is a lot of information gathered in the healthcare sector, but this information needs further analysis in the next periods to make the most use of them.

Digitalisation needs investments and optimizing the costs is a common driver of using innovative technology. Although there are financial measures that enable innovation, the high technological solutions remain often too expensive.

Innovational technological possibilities are not known widely, so the decision makers don't know what the most recent technological possibilities are.

Small Market

Estonia is rather small, so we always need to see how we can go abroad with different solutions that we create. However, due to the dynamic environment Estonia is suitable for piloting and co-creation.

Public and Private Sector Cooperation in Digitisation of Healthcare

The government is working on development of an infrastructure for cooperation projects- like sandboxes e.g., so that enterprises could come and test their products on data from various datasets (genomic, health, clinical) in Estonia.

Recent Developments

COVID – 19 has speed up innovation and different solutions that enable social distancing. In the beginning of the Corona crisis the Estonian Health Insurance Fund reacted in days and started promptly to remunerat teleconsultations.[16] This measure prevented that regular treatment would have been paused and kept away the infection in risk groups and medical personnel. It was possible as the plan to use virtual consultation, but due to the crisis, the application was used earlier and more actively than planned. Teleconsultations were very well received by patients and medical professionals and ⅔ of all doctor's appointments were done remotely.

Another example is the "HOIA" app for anonymous detecting contacts between mobile phones and informing people who have been in close contact with coronavirus carriers. There are also an increasing number of applications to optimise health and social care costs.

Some examples. An app for Sclerosis Multiplex patients for home surveillance of movement and other parameters enabling to analyse the condition of the patient and react on time to the changes,[17] or an indoor GPS patient monitoring system for an Estonian rehabilitation center to evaluate the effectiveness and impact of rehabilitation.

Telemedicine improves the healthcare of patients living in the remote areas. With the applications it is possible to reduce the impact of lack of medical personnel in remote areas - possible to use doctors to get a second opinion from another doctor and for a patient to visit a specialist of some specific field.

Road Ahead

The market growth will probably follow the overall development in the world. Expectedly, the growth will be bigger when the state is able to set up a cooperation framework for development of new products and services.

In the next 5 years, using the health and genomic data will be available to create new services and products for the private sector. Estonia has a valuable asset as a long-term digital health data, but we are not making much out of it now. There is the potential that we can create new services and products based on health data that is available and other digital data that Estonia is rather good at.

Genomic data will be used in practice for prevention and health promotion incl. cancer risks, in clinical practice and in personal prescription of medications.

Wider use of patient home surveillance devices for providing healthcare from distance and less hospitalisation - using sensors and measurement devices combined with the apps that collect and

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[16] https://www.haigekassa.ee/partnerile/raviasutusele/kaugvastuvotud, accepted 16.09.2020

[17] https://www.astrakliinik.ee/sclerosis-multiplex/kodumonitooring-muutub-sclerosis-multiplexiga-inimeste-jalgimisel-uha-tahtsamaks/, accessed 27.08.2020

monitor the information, enabling the personalised medicine from distance. Monitoring of cancer risks are more visible for people so they could take actions to prevent it.

Expert opinions were shared by the following experts:

1. Katrin Kaarna - Institute of Clinical Medicine, University of Tartu, Tartu University Hospital, Project of National Centre for Translational and Clinical Research
2. Andres Salumets - The Competence Centre on Health Technologies, CCHT
3. Carmen Siitsman - ELIKO Tehnoloogia Arenduskeskus OÜ
4. Kalle Killar - Estonian Ministry of Social Affairs
5. Kitty Kubo - Estonian Health Insurance Fund

(read more from Report on Joint Marketing Opportunities - https://drive.google.com/file/d/17PZL1ybh27QE4TtzNJvd8fV6zutCD4G2/view)

Useful links – Report on Joint Marketing Opportunities

https://drive.google.com/file/d/17PZL1ybh27QE4TtzNJvd8fV6zutCD4G2/view

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DANISH LIFE SCIENCE PLAYS AN IMPORTANT ROLE FOR THE DANISH SOCIETY

The Danish Life Science Industry plays an increasingly important socio-economical role for Danish society. There are more than 1500 life science companies in Denmark with more than 47.500 employees (= 2.2 % of the workforce), and export growth from DKK 40 bn in 2007 to DKK 151 bn (= 22% of the total export) in 2020.

The Danish life science industry invests yearly DKK 15 bn in their own research, and foreign life science companies invest annually DKK 34 bn in research and development in Denmark. Apart from Switzerland, this makes Denmark the country worldwide that invests most in private pharma research and development. And it makes the pharma industry the sector in Denmark investing the most in research.

At the same time, the Danish health care system is facing a democratic challenge with an aging population, an increase in the number of citizens with multiple chronic diseases and rapidly increasing health care costs while at the same time qualified health care personnel is becoming a limited resource. Altogether challenges where the solutions can be found by developing partnerships between academia, hospitals, and industry with a focus on prevention, developing better diagnostics and medicines, better use of health data, and digitalization and automatization of processes.

Danish Life Science Cluster

Introduction to Danish Life Science Cluster – a knowledge broker in the Danish life science ecosystem

Research is the necessary basis for the development of new drugs and health care and strong collaborations between Danish research institutions, hospitals, and companies are seen as an important prerequisite for the success of the Danish Life Science Industry.

Danish Life Science Cluster supports knowledge sharing and facilitates collaboration between research and industry to translate Danish research into new and better commercial solutions for the benefit of companies, healthcare, municipalities, and citizens throughout the country [1].
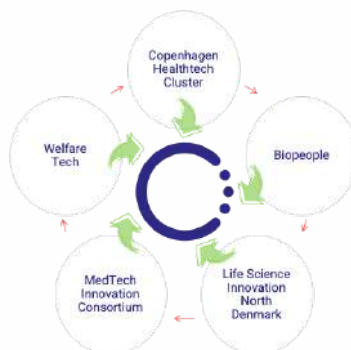
Danish Life Science Cluster was established in 2021 by the merger of five regional life science clusters. The purpose of the merger was to create a strong national organization covering both life science, welfare technologies, and health data while at the same time having a strong regional anchoring from regional hubs placed in proximity to the largest research institutions and hospitals in all areas of Denmark. Today we have hubs located in Copenhagen, Aarhus, Odense, and Aalborg and a fifth hub is planned to be established close to the hospital in Nykøbing Falster in Region Zealand.

The strong regional presence is combined with national activities and collaborations between the individual hubs and their stakeholders, and furthermore with an international outreach from participation in various projects outside Denmark.

A broad partnership supports Danish Life Science Cluster

Organizations from both industry, academia, regions, municipalities, and business organizations were founding partners of Danish Life Science Cluster (see appendix) and are represented on the board.

Danish Life Science Cluster is financed by grants from the ministry of research and higher education and the ministry of industry, business, and financial affairs, as well as funding from externally financed projects, and membership fees from 219 paying members (143 companies, 17 research institutions, 36 municipalities, five regions, and 18 sector- and business organizations).

1. https://www.danishlifesciencecluster.dk/danmarks-nationale-sundhedsklynge/

A short presentation of three of the major stakeholder groups supporting Danish Life Science Cluster

The Danish healthcare system is represented by the five regions and Local Government Denmark (also known as Kommunernes Landsforening) is one of the founding partners of Danish Life Science Cluster.

The Danish healthcare system is based on the principles of free and equal access to healthcare for all citizens. The healthcare system offers high-quality services, the majority of which are financed by general taxes [2].
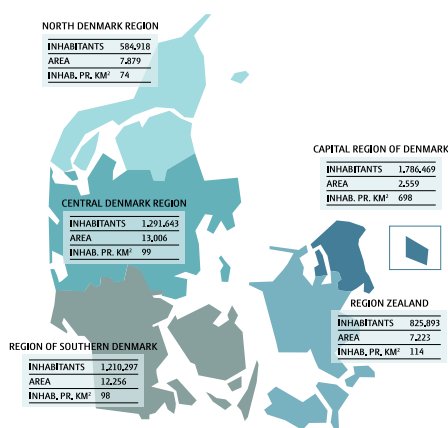

NORTH DENMARK REGION
INHABITANTS	584,918
AREA	7,879
INHAB. PR. KM²	74

CAPITAL REGION OF DENMARK
INHABITANTS	1,786,469
AREA	2,559
INHAB. PR. KM²	698

CENTRAL DENMARK REGION
INHABITANTS	1,291,643
AREA	13,006
INHAB. PR. KM²	99

REGION ZEALAND
INHABITANTS	825,893
AREA	7,223
INHAB. PR. KM²	114

REGION OF SOUTHERN DENMARK
INHABITANTS	1,210,297
AREA	12,256
INHAB. PR. KM²	98

Figure 1 - source: https://www.regioner.dk/ambulance-in-dk/about

The **Ministry of Health** is responsible for establishing the overall framework for the provision of health. This includes legislation on the organization and provision of health services, patients' rights, healthcare professionals, hospitals and pharmacies, medicinal products, vaccinations, maternity care, and child healthcare. The legislation covers the tasks of the regions, municipalities, and other authorities within the area of health [3].

Denmark is divided into **five regions** that differ in relation to their physical geography, areas, and populations. For example, more than 30 percent of the inhabitants of Denmark live in the Capital Region of Denmark, which at the same time is the smallest region in terms of its area [4].

The regions have the responsibility for all treatment provided by the Danish Healthcare System. The regions operate public hospitals. The regions are also responsible for the medical practice sector's functioning. For example, the regions are the guarantors for all Danes having access to a practicing physician. The regions also enter into agreements with a number of privately practicing specialist physicians and other occupational groups, for example, dentists, psychologists, and physiotherapists, whose services are used by Danish citizens [5].

Danish
Life Science
Cluster

2. https://www.healthcaredenmark.dk/media/ykedbhsl/healthcare-dk.pdf
3. https://www.healthcaredenmark.dk/media/ykedbhsl/healthcare-dk.pdf
4. https://www.regioner.dk/media/1334/regionerne-kort-fortalt-2011-engelsk.pdf
5. https://www.regioner.dk/media/1334/regionerne-kort-fortalt-2011-engelsk.pdf

Apart from the 5 regions, Denmark is furthermore divided into 98 municipalities that are responsible for several health and social services. Local health and elderly care services include disease prevention and health promotion, rehabilitation outside hospital, home nursing, school health services, child dental treatment, child nursing, physiotherapy, alcohol, and drug abuse treatment, home care services, nursing homes, and other services for elderly people. In addition, municipalities co-finance regional rehabilitation services and training facilities.

Another large stakeholder group supporting Danish Life Science Cluster is the academic institutions in Denmark. The five largest universities and five of the Research and Technology Organizations were founding partners, and after the founding of the organization further universities and research institutions have become members of the cluster.
There are a total of 33.565 FTEs and 150.500 students enrolled at the Danish universities, and they have a combined annual budget of DKK 30 bn.

Danish universities have a strong research tradition which can be measured directly in the number of research publications, and Danish academia is currently on a second place worldwide when measured on a number of publications per capita (data from the period 2015-2019).

A unique type of research organization in Denmark is the government-approved Research and Technology Organisation (called GTS institutes) that plays a key role in the Danish innovation system as a link between technology and business. They are publicly owned but are run as independent companies with the primary goal to make new technological methods applicable to businesses and promote businesses' uptake of new technology. They play an important role in the Danish innovation support system as providers of new technologies for the Danish companies.
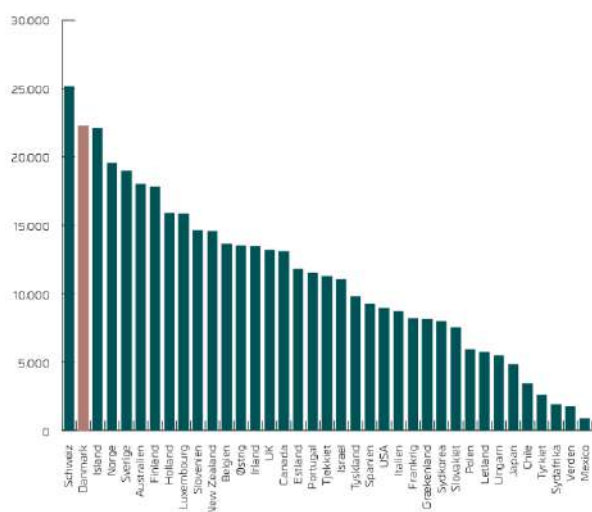
Kilde: OECD og Uddannelses- og Forskningsministeriet via Scival

Danish
Life Science
Cluster

Presentation of the danish life science industry

The industry plays an important part in the life science ecosystem. There is a strong tradition for collaboration between industry, universities, and the public health sector, which makes Denmark a hotspot for pioneering R&D [6]. Collaboration between companies and clinicians, for instance, strengthens research and treatment. Apart from Switzerland, Denmark is the country worldwide with the heaviest investment in private pharma research and development [7].

The progressive innovation of major international pharmaceutical companies such as Novo Nordisk, Lundbeck, LEO Pharma, and ALK has created one of the world's strongest biotech and pharma clusters [8].

The Danish life science industry makes a large and important contribution to the national economy, including exports of life science products of DKK 152 bn in 2020 [9].

In total, more than 47.500 people are employed in approximately 1500 life science companies in Denmark [10] (2016 figures). Of these, approx. 850 companies produce medical devices, the largest being Oticon and Coloplast. Approx. 550 companies are primarily pharmaceutical and biotech companies, respectively. The remaining approx. 100 companies produce both medical devices and pharmaceutical products/biotech, the largest being Novo Nordisk A/S. The majority (approx. 80%) of the 1500 life science companies are micro-companies (0-9 full-time employees).

6. https://investindk.com/set-up-a-business/life-sciences/pharma-biotech
7. http://publikationer.lif.dk/lifs-key-figurespixi-versionuk2020/?page=8
8. https://investindk.com/set-up-a-business/life-sciences/pharma-biotech
9. https://em.dk/ministeriet/arbejdsomraader/erhvervspolitik-og-planlaegning/life-science/
10. https://em.dk/media/12998/lifescience-industriensfodaftrykpaadanskoekonomi_damvad.pdf

Our ambition is to build a world class life science cluster

Danish Life Science Cluster has the ambition to build a national cluster that can compete with the best life science clusters in the world, measured by the number of knowledge-based collaborations among stakeholders in the ecosystem as well as by ensuring growth in companies and the ability to commercialize research and knowledge.

We will do this by strengthening the collaboration and supporting partnerships between the stakeholders in the national life science ecosystem by the following activities:

- Increase contact between researchers from academia, hospitals, and industry through **networking activities (**e.g., site visits at both industry and research institutions).
· Support **knowledge sharing** (e.g by organizing and hosting symposias and conferences).
- Increase **co-creation, innovation, and learning** (e.g., by facilitation at dialogue meetings, hackathons, and workshops).

- Facilitating collaboration and **Public-Private-Partnerships** as a method to increase innovation (e.g., in strategic projects participants from both public and private organizations).

- Support **promotion and visibility** of members and stakeholders through our communication channels by sharing success stories and news.

- Attract **international talent and funding** by sharing research results and success stories from the Danish ecosystem at international events and through collaboration in international projects.

Examples on core activities in the cluster

Network activities – increasing contact and knowledge sharing between academia and industry

- **The NGS tech network** – a network for researchers working with Next Generation Sequencing (NGS) and looking for inspiration. The NGS Tech network aims to grow a community of national NGS enthusiasts who wish to gain new knowledge and discuss challenges to push the technology to the next level. The network is founded by researchers from both academia and companies. (For more info)

International projects provide both knowledge, visibility, and access to new markets to participating companies

- The **Accelerate Health Innovation Across Boundaries** project is a German-Danish project with a focus on common healthcare challenges in the Danish and German market (For more info)
- Digitalization is high on the political agenda in the EU. The technological development in artificial intelligence (AI) and data processing creates new opportunities for better and more resource-efficient solutions and services. Not least in the elderly care sector, where an increasing number of older people and a decreasing labor force put massive pressure on the sector. **The Care-AI network** project promotes this development by establishing a sustainable, interdisciplinary network across the German-Danish border. The network invites relevant research institutions, elderly care organizations, companies, and other relevant stakeholders to participate, share and co-create knowledge, ideas, and experiences about digital and AI solutions focusing on elderly care. The cross-border network collaboration will identify current, urgent, and potential future needs and challenges related to the digitalization of elderly care to increase its quality. Moreover, the Care-AI network project provides the opportunity to strengthen partnerships and develop new projects ideas for demand-driven AI solutions (For more info)

In Denmark, public-private innovation is a highly used method for generating new solutions for societal needs

- The **Clinical Decision Support System** project is a research collaboration that develops a clinical decision support system based on artificial intelligence to help health personnel in municipalities and hospitals identify citizens who are at risk of acute hospitalization (For more info)
- **Genstart** is a project analyzing the bottle necks preventing the use of health data and potential solutions for these. The project is funded by the ministry of research and higher education and the ministry of industry, business, and financial affairs (For more info).

Danish
Life Science
Cluster

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Appendix - Founding partners

Universities
Aalborg Universitet
Aarhus Universitet
Danmarks Tekniske Universitet
Københavns Universitet
Syddansk Universitet

Research and Technology Organizations
Alexandra Instituttet
Bioneer
DHI
Force
Teknologisk Institut

Regions and municipalities
Region Nordjylland
Region Midtjylland
Region Syddanmark
Region Hovedstaden
Region Sjælland
Kommunernes Landsforening

Industry organizations
Lægemiddelindustriforeningen
MedicoIndustrien
Dansk Biotek
Danish Care
Dansk Industri
Dansk Erhverv