Ministry of Foreign Affairs

Digitalisation of the Life Sciences & Health Sector in France

Opportunities for FR-NL collaborations to improve health and healthcare-
Two case studies: Île-de-France and Auvergne-Rhône-Alpes

Commissioned by the Netherlands Enterprise Agency and the Innovation Department of the Embassy of the Kingdom of the Netherlands in France

>> *Sustainable. Agricultural. Innovative. International.*

Contents

Context and objective of the study

France and The Netherlands share the same societal and economic challenges when it comes to health and care: ageing, increase in chronic diseases, health inequalities, to name but a few. At policy level focus is put increasingly on the following topics:

- prevention (linkage with lifestyle and nutrition),
- sustaining access to quality care for all citizens,
- stimulating (integral) homecare,
- further developing personalised care and
- increasing effectiveness (value based healthcare) and cost-efficiency.

Increasing digitalisation in health (care) has the potential to further improve both the quality and the security within our health care systems. Digitalisation can also save more lives as patient data are increasingly shared among health care providers. Consequently, our health care systems need to modernise and adapt further to increasing digitalisation and the potential it offers to patients, to their (home) environment and to health care providers. Moreover, further digitalisation can contribute to keep budgetary developments under control and possibly even reduce expenses in the health care system.

It is clear that no country can solve the digital challenges on its own. International cooperation is key in finding the appropriate solutions to these challenges.

France and The Netherlands already collaborate intensively in the field of ICT and health, including in the context of European R&D and innovation programmes such as Horizon 2020. Indeed, of all Horizon 2020 projects awarded to French research institutes and enterprises, 30% is being carried out with partners from The Netherlands, in particular in ICT and health.

This strong European base led the Innovation department within the Embassy of the Kingdom of the Netherlands in France to commission a report, in 2017, on the French health care system carried out by the Dutch Task Force Health Care (TFHC) in collaboration with Transfer.[i] This report highlighted the bilateral interest in strengthening the cooperation in the fields of:

1. Hospital build (design, construction and equipment of hospitals)
2. Digitalisation of health care
3. Public health
4. Life science & biotech research
5. Medical devices
6. Mobility and vitality

Aforementioned bilateral interest was confirmed during an economic mission led by minister Bruno Bruins, ministry of Health, Well-being & Sports, to France in May 2019, accompanied by 21 research institutes and companies. Particular focus during this mission was put on digitalisation and key enabling technologies such as Artificial Intelligence.

This report on the digitalisation of the Life Sciences and Health (LSH) sector in France, focusing on the regions Ile-de-France and Auvergne-Rhône-Alpes, is aimed at facilitating the next steps to take in this fruitful collaboration between France and the Netherlands. It provides an overview of the main players, both public and private, in these specific regions with which cooperation has been intensified over the past two years. It is foreseen that cooperation in the field of e-health with other regions could be extended in the year 2020 and beyond.

Introduction to digitalisation in LSH/e-health

This chapter gives a short introduction to digitalisation in LSH, before starting with France's national e-health policy (Part I), , also named e-health, and aims to set the definition and the subdivision of e-health.

Health tech is the umbrella term for three areas: BioTech, MedTech and e-health. E-health, can be described and subdivided in numerous ways.[ii]

In this report, the following definition of e-health is used: the use of information and communication technologies to improve and/or support health(care).

Examples of technologies that are being used to improve healthcare are: Artificial Intelligence (AI), Internet of Things (IoT), cybersecurity, cloud, big data and blockchain.

To further subdivide e-health, two distinct domains can be defined:

(1) Interoperability of systems

To define interoperability of systems in this report, the definition of K. Stroetmann (2014) is used: "*facilitating and safeguarding the exchange, understanding and acting on patient and other health information and knowledge among linguistically and culturally disparate medical professionals, patients and other actors within and across health systems in a collaborative manner*."[iii] This includes for example platforms and connecting services.

(2) Tele-health

For tele-health, this report refers to the definition of the WHO (2010): "*The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities.*" [iv] The term telemedicine can also be used for tele-health. There is no uniformity in the difference between these two terms and in this report the same definition will be used for both terms.

As can be seen in part I "national e-health policy", and the chapters "healthcare providers" and "Industry" of this report, the definition tele-health can in turn be subdivided in different categories. This report will discuss four subcategories: teleconsultation, tele-expertise, tele monitoring, tele-education and tele surgery.

PART I THE NATIONAL E-HEALTH POLICY

The French government has built a strong and extensive national e-health policy over the past few years. Roadmaps are rolled-out and numerous national e-health projects are being carried out in all fields.
The government encourages the interoperability of systems on different national levels: citizens, healthcare professionals and research. An example is the end 2019 inaugurated national health platform for research, the Health Data Hub.
Next to interoperability, the French policy emphasises the relevance of tele-health, especially because of the huge amount of rural areas in France. A concrete example is the in 2018 introduced law that declares that teleconsultations with a doctor are billed in the same way as for a traditional consultation.
Besides, the French government strongly stimulates innovation in health care, by for example opening an e-health Lab for startups and by offering various financial solutions to support for instance the hospital information systems and medical and social organisations to make the digital transition.

This first part elaborates on the initiatives the French government takes to release the full potential of e-health and is divided in four chapters: Recent developments in e-health policies (1.1), Roadmap for digitalisation in healthcare (1.2) National e-health projects (1.3) and Public investments (1.4).

1.1 Recent developments in e-health policies

A successful digital transformation of the LSH sector relies to a large degree on the collaborations and coordination between the various stakeholders in this sector. Policies and governing bodies are of particular importance to guarantee the quality and the security within our health care systems. This first chapter shorty lists the recent developments in the French policy on the field of e-health.

July 2016 - National e-health strategy 2020
The National e-health strategy 2020 was launched in July 2016 by the Minister of social and health affairs. More information about this strategy can be found in the Market Study performed by Task Force Health Care. [v]

March 2018 – AI for Humanity
End of March 2018, the French President Emmanuel Macron presented his vision and strategy to make France a leader in Artificial Intelligence (AI), his strategy was based on the *AI for Humanity* report, a mission led by French deputy Cedric Villani on Artificial Intelligence. The report describes health as one of the three priority themes in the development of AI in France.[vi]

September 2018 - Ma Santé 2022*:* a strategy for a transformation in the healthcare system
President Macron started the presentation of the new policy *"Ma Santé 2022"* with an alarming diagnosis: *"our health system has become unsuitable: it no longer meets the expectations of patients and feeds the dissatisfaction of the doctors and professionals."* The reforms of the French healthcare system are geared towards: (1) Patient-centred and quality-oriented care, (2) collaborations between care providers for efficient distribution of care (3) the (digital) evolution of the sector and the jobs. The total budget for this new health policy plan is 3.24 billion euro, of which 500 million is allocated to the digital transition.[vii]

April 2019 - A roadmap to accelerate the digital transformation and enhance the security
Based on the policy *"Ma Santé 2022"*, the French government presented a National e-health policy for the period 2019-2022 in April 2019.[viii] The next chapter will explain what the new policy entails.

1.2 Roadmap for digitalisation in healthcare

The National e-health Policy, launched April 25th 2019, is based on five pillars and a roadmap with 26 action points. This chapter will explain per pillar what the new policy plans involve in order to illustrate how the French healthcare system is changing.

Pillar 1: Strengthening the digital governance

A new department is set up within the ministry, the ministerial delegation of digital health (Délégation ministérielle du numérique en santé, DNS), to manage the digital health agency (Agence du numérique en santé, ANS) (formerly l'Agence des Systèmes d'Information Partagés de Santé (ASIP Santé)). The ANS has the task of implementing the new roadmap.

Pillar 2: Intensifying safety and interoperability of healthcare systems

The French government wants all healthcare providers to contribute to digitalisation. To make that easier, the interoperability should be improved, first of all by generalising the identification of healthcare professionals. On the patient's side, a national health ID (identifiant national de santé, INS) is being developed. This allows a patient to be followed throughout their care path.
Authentication systems such as the national insurance card (Carte Vitale) will be dematerialised by a new application. With the app, access to medical teleservices will also be secured.
To ensure that old and new systems can communicate with each other, a research was launched at the end of 2019 into the required common interoperability standards. If necessary, new standards will be put into law.
Security is at the basis of all digitalisation. That is why the French ministry of solidarity and health implemented on October 2017 a website that processes reports of information system security incidents.[ix] It is mandatory for health structures (health establishments, army hospitals, radiotherapy centres and medical biology laboratories) to immediately report their incidents, which are 1. safety of healthcare 2. the confidentiality or integrity of health data and 3. normal functioning of the establishments, the organisation or service. Besides the expansion of the security incident reporting system for healthcare providers, a national cyber surveillance service in health care will be established in 2020. [x]

Pillar 3: Accelerating the deployment of digital services

Data exchange and sharing should be safe and easy. The rollout of the Shared Medical Dossier (*Dossier Médical Partagé*, DMP) started in November 2018. Since then 5 million French have a DMP and an additional 100,000 are added every week. To stimulate its use, the interface is currently being adjusted to improve user-friendliness and new features will be added from 2020, such as the vaccination booklet. From 2021, every person will receive a DMP at birth. By 2022, the DMP must be fully integrated into the Electronic Care Environment (*Espace Numérique de Santé*, ENS - more on that below). For more information about the DMP see appendix 1.

Secure messaging is facilitated with the MSSanté messaging service. This service enables all health professionals to share information securely via email. The ANS will oversee the further rollout of this pilot in collaboration with stakeholders, from healthcare professionals and insurers to regional authorities. To simplify and secure the sending of prescriptions to pharmacists, the e-Prescription will be developed on a national level systematically between 2019-2022.

Pillar 4: Implementing national digital platforms

Three platforms are being set up to facilitate safe and easy access to digital services and information for healthcare users and providers:

- Electronic Patient Environment (ENS): for every citizen

The development of the ENS was made possible with the new Care Act. The first proof of concepts must be finished in 2020 and the platform will be opened in 2022. Each citizen will have access to all of their own care information and services (secure messaging, teleconsulting, appointment system, connected wearables, etc.).

• Services platform: for healthcare professionals

This platform called **"bouquets des services"** mirrors the ENS, being a platform for healthcare professionals to gain access to relevant information and services. For example, a doctor should have access to a portal where they can follow a diabetic patient through an app, without having to leave their own software environment. The service platform will bring together a wide variety of applications. Its development will start in 2020 with proof of concepts and should be finished by the end of 2022.

• Health Data Hub: for research

Fittingly named, the Health Data Hub will be the hub for health data. There is a huge amount of data, but to be able to use it for research, an improvement in structuring is needed. This includes linking databases and uniform labelling of data. If done ethically and securely, everyone will benefit from these large data sets being available for research purposes. The link with the AI for Humanity report from Cédric Villany (CF Chapter 1.1) is evident, in which health is one of the three main themes. The Health Data Hub has been officially inaugurated in December 2019. For more information about the Health Data Hub, its structure and its progressions see appendix 1.
Pillar 5: Supporting innovation and promoting stakeholder involvement

Since September 2018, health insurers in France reimburse tele-consultations and -expertise. Teleconsultations are billed in the same way as for a traditional consultation, but the patient has to be referred by his or her doctor and should have had at least one physical consultation with his or her doctor during the last twelve months.
For the further development of tele-health, the French National Authority for Health (Haute Autorité de Santé, HAS) has been instructed to make new recommendations to better integrate tele-health into the care system. Here too the emphasis is on interoperability. The French government sees many opportunities in further development of telemedicine to reduce the "medical deserts" (area's where the population has difficulties in accessing general practitioners, pharmacies and emergency services. Reasons for those deserts are the shortage in physicians and the disparity in density of doctors between the rural and urban areas). The HAS published in 2019 a report to support the rollout of tele-health and gives an overview of which forms of telemedicine are being used per medical specialty.[xi]

Major investment programmes include the "*Hôpital numérique ouvert sur son environnement*" (***HOP'EN***) programme of €420 million for the development and support of hospital information systems (started in February 2019) and the "*Digital Social and Medical Services*" (ESMS) plan to help medical and social organisations make the digital transition (starts in 2020).

The DNS will establish the e-health Lab in March 2020. The goal is to stimulate innovation in digital health services. The Lab will identify new e-health concepts, provide possibilities to test new products of startups, and technologies and actively inform the market through their website Labsanté.fr and through innovation clusters about existing products to accelerate the use of e-health solutions.
In June 2020, the DNS plans to create a national network of healthcare providers with the goal to test innovative solutions of startups in real conditions.

Finally, public opinion about the digitalisation strategy is taken into account at national political debates. This 'Tour de France e-**santé'** of e-health took place from September 2019 to February 2020. Citizens are also involved in the development of the ENS. Workshops are organised throughout the entire development period from 2019-2022 to familiarise (future) users of this digital healthcare environment and to include them in the design of the platform. [xii]

1.3 National e-health projects

Part of the roadmap for digitalisation in healthcare are the National e-health projects. This chapter gives a short introduction to these national projects.

The National e-health projects are implemented by the ANS, commissioned by the public authorities. These e-health projects aim to accelerate the digital transformation of the healthcare system for the benefit of patients and professionals. At the moment thirteen projects are launched and can be subdivided in three categories:

1. Construction and deployment of national programmes for existing healthcare services, such as the programme called SI-SAMU, a programme to modernise the French emergency medical service (S*ervice d'Aide Médicale Urgente*, SAMU).

2. Implementation of unified national portals, like the website Santé.fr and its mobile application. Both portals provide information on health, pathologies and the offer of existing healthcare and services (e.g. via a geolocation service).

3. Convergence of existing programmes in the territories, for example the E-parcours programme, a programme to improve the coordination between professionals in prevention, care and medico-social support. Part of E-Parcours is the elderly people at risk of loss of autonomy programme (Personnes Agées en Risque de Perte d'autonomie, PAERPA). The objective of this programme is to maintain the elderly person (+75) in the greatest possible autonomy, for as long as possible and in his or her usual living environment.

A complete list of the currently ongoing programmes can be found in appendix 2.

1.4 Public investments

As already mentioned in chapter 1.2 "Roadmap for digitalisation in healthcare", a considerable amount of public initiatives exist to promote financing the e-health sector. Besides the already existing public investments such as the *Crédit d'impôt Recherche*, new initiatives were created the past few years. These initiatives are rolled out by organisations such as The "Banque Publique d'investissement" and "La French Tech". The following chapter will introduce those programmes briefly.

Public investment programmes

Crédit d'impot Recherche (CIR)
The CIR aims to support companies in their research and development activities. Companies that carry out fundamental and applied research or experimental development can benefit from the CIR by deducting a certain amount from their taxes (up to 30% tax credit for amounts less than 100 million euros). The R&D can be done within the organisation itself or it can be outsourced to a French or non-French organisation. Foreign public and private knowledge institutes and companies can request an R&D accreditation after which they can carry out research for French clients that request the CIR. [xiii, xiv]

Crédit d'impôt innovation (CII)
The CII, created by the 2013, is an expansion of the CIR. Its objective is to support companies incurring specific expenses to innovate. The tax credit is 20% for all expenditures incurred with a maximum of expenses of €400.000. [xv]

Jeune Entreprise Innovante (JEI)
The JEI, created in 2004, allows SMEs, existing less than eight years, to benefit from multiple tax breaks and social exemptions if their research and development expenses represent at least 15% of their expenses.

Programmes **d'Investissements de l'Avenir (PIA)**
The PIA is set up to finance innovative and promising investments in France, in order to increase its growth and employment potential. The total budget of the PIA consists of 57 billion euros. Health and biotechnology are part of the strategic axes and 3 billion euros are allocated to these sectors to support ten university-hospital research projects in 2016 with nearly 80 million euros.[xvi]

National funding organisations

Banque publique d'investissement (Bpifrance)
Bpifrance is a funding and business development agency dedicated to supporting SMEs, midcaps and innovative companies. In 2015, Bpifrance invested in thirty-five health tech companies for a total amount of nearly 135 million euros, and in parallel financed more than 500 other companies with 206 million euros.

La French Tech
La French Tech unites French startup ecosystems in France and internationally. It has the aim to make France a "digital" republic and to support French startups and guide them subsequently internationally. One of the nine focus themes of la French Tech is health tech. The French Tech has different financing programmes for their startups and scale-ups like the "French Tech Community Fund", the "Bourse French Tech", the "French Tech Fonds Acceleration", the "French Tech Seed". La French Tech also leads two acceleration programmes for the top selected French startups and scale-ups: "La French Tech 120" (120 startups in a hyper-growth phase) and "Next 40" (40 scale-ups with the high potential to become a unicorn).[xvii]

Part II MAPPING TWO E-HEALTH ECOSYSTEMS: ÎLE-DE-FRANCE AND AUVERGNE-RHÔNE-ALPES

This part zooms in on the regions Île-de- France and Auvergne-Rhône-Alpes (AURA) and maps out the most relevant players in both e-health ecosystems. Important stakeholders in the field of the digital transformation in healthcare and their activities will be elaborated here. These stakeholders are divided in the following categories: clusters, knowledge institutes (subdivided in research and education), healthcare providers (subdivided in hospitals, purchase organisations and care facilities), industry and support for startups (subdivided in incubators, accelerators and investors).

Both Île-de-France and AURA are dynamic regions where hospitals, clusters, research institutes and companies work together on e-health. Île-de-France is one of the leading European regions in terms of research, development and innovation. The European Commission states that in 2016, Île-de-France represented 39.8% of all EU investments in France's expenditure on R&D.[xviii] AURA is after Île-de-France the second largest region in number of inhabitants. Having the second biggest university hospital (CHU) and a dynamic ecosystem of startups, Lyon is a very interesting city regarding innovation in LSH.
Besides the potential opportunities in both regions, an intensive bilateral cooperation exists between the Netherlands and these two regions supported by the Dutch embassy based in Paris and the Netherlands Business Support Office (NBSO) based in Lyon. Against this background, the decision was made to focus in this report on these two regions. Further research could explore other regions, like for example Hauts-de-France or Nouvelle-Aquitaine.

2.1. Competitiveness clusters

In France, the competitiveness clusters are called *Pôles de compétitivité.* They bring together small and medium-sized companies, research centres, universities and associations in a given area in order to develop synergies and cooperation. For foreign companies or knowledge institutions, the *pôles de competitivité* are a good way to identify and approach a group of companies and knowledge institutions around a specific topic. Foreign companies with an office in France located in the periphery of such poles can become a member. Companies that are not part of the cluster do have the possibility to participate in a research project within the cluster. France has eight clusters exclusively on LSH with each (slightly) different domains of activity.

The health cluster in the region Île-de-France is Médicen. The focus themes of Médicen are: e-health, biological diagnosis, imaging, biotherapies and techno-therapy.[xix] In the region AURA, Lyonbiopôle is the regional health cluster. The focus themes of Lyonbiopôle are medical technologies, medical devices and human and veterinary medicines. [xx] A complete overview of the *pôles de competitivité* in LSH of the other regions in France are included in appendix 3.

Next to the eight LSH clusters, clusters in the field of digital technologies sometimes work on health themes. In Île-de-France, one of this type of clusters is called Cap Digital. [xxi] The in the AURA situated cluster Minalogic, has various e-health companies members. [xxii] Additionally, some specialised clusters in Île-de-France and the AURA and their areas of activity are added to appendix 3.

2.2 Knowledge institutes

This chapter gives a non-exhaustive overview of the research institutes and universities with programmes in e-health in the regions Île-de-France and AURA.

2.2.1. Research

France is known for its quality of research. It is a breeding ground for knowledge, in particular in the field of health, medical research and technology. Two recent examples to illustrate this:

1. The nomination of the National Institute for Health and Medical Research (Institut National de la Santé et de la Recherche Médicale, INSERM) as one of the top 10 of world's most innovative public organisations [xxiii]
2. The nomination in 2018 of the national centre of scientific research (Centre National de Recherce Scientifique, CNRS) ranked in the fourth position among place of institutions with the largest contribution to papers published in the prestigious scientific journal, Nature.[xxiv]

Despite the strong foundation, a report of the Boston Consulting Group (BCG) about the French health tech sector published in 2017 states that research in companies is currently more attractive than research in public institutes. It is a challenge for France to improve the limited wages and rigidity of the public research system (recruitment, mobility, redeployments), according to BCG. As a result, skills sought by players in the biomedical innovation sector are currently said to be lacking in the labour market. [xxv]

The availability of data is fundamental in R&D and AI. A report from the French ministry about the state of the art and the perspectives of AI in France published in 2019 stated that access to data is the current major brake in developments in AI in France. The rapport indicates that among the interviewed people, multiple years in average are needed to obtain data in France. However, this problem is of lesser importance for the niches imaging, electrocardiogram, transplantation and medical publications.[xxvi]

The following subchapter illustrates major research institutes in the regions Île-de-France and AURA and specifies on their activities on e-health. Some of the institutes like the National Institute for Research in Computer Science and Automation (*Institut National de Recherche en Informatique et Automatique*, Inria) and the Institute for Interdisciplinary Research and Education in AI (3IA) are present in both regions.

It can be observed that the focus areas of the different research institutes are distributed. In both regions research is performed in fields as diagnostics, personalised medicine, the use of AI in biological systems and many others. Research on e-health appears to be on all levels: from the molecular to the epidemiologic level. One difference between the research institutes in the two regions that are mentioned below is the amount of institutes in Île-de-France performing research in the field interoperability of systems compared to region AURA.

➢ REGION ÎLE-DE-FRANCE

INSERM and Université Sorbonne Paris Nord

The Laboratory in Medical Informatics and Knowledge Engineering in e-health (LIMICS) is a laboratory in medical informatics and knowledge engineering in e-health. This research unit is financed by INSERM and Université Sorbonne Paris Nord.

LIMICS performs research in two axes:

- The first axis is the development of new means for the collection of standardised structured data, both for the Electronic Healthcare Record and for the constitution of cohorts and clinical trials;
- The second axis comprises the theme design methods and tools for the development and evaluation of terminological and ontological resources in health. [xxvii]

L'Institut Carnot SMILES

From the research laboratories which are labelled Carnot, the Institut Carnot SMILES is specialised in mathematical modelling, digital simulation and data science. In the field of e-health, the laboratory focusses on the following themes:

- Design of filters that can be used for the classification and recognition of acoustic and visual signals;
- Dimension-reduction;
- Early and reliable event detection;
- Optimisation of statistical learning;
- Supervised and unsupervised statistical learning.[xxviii]

These research projects have the following applications:

- Decision support with the use of big data;
- Follow-up after vaccination;
- Personalised medicine;
- Pharmacovigilance. [xxix]

Institut Curie

Institut Curie operates three research centres (on biophysics, cell biology and oncology) and one hospital that is specialised in cancer treatment. The institute comprises three sites, each having different themes of specialisation:

- Saint-Cloud: precision medicine, patient's journey and data collection
- Paris: systems biology and the overall patient care
- Orsay: radiotherapy

With regards to e-health, Institut Curie focusses in particular on the accessibility of clinical data for research and eventually has plans to create a data centre. This centre will bring together all the equipment and data of the information system. Moreover, it is a goal of Institut Curie to become a leader in the field of data analysis in oncology.

To support outpatient medicine the institute develops digitals tools facilitating the exchange of information. An example is the application mycurie.fr. This app gives patients access to personalised information about their treatment, medical journey and doctor. Next to this, the institute has created two other e-health tools, *Chemo app* and *Virtual Reality*. *Chemo app* is an application that monitors the side effects of cancer drugs and *Virtual Reality* aims to reduce patient anxiety. [xxx]

Institut national de recherche en informatique et automatique (Inria)

Inria, the national research centre of computer sciences and applied mathematics, opened the Inria Paris Research Centre in 2016. Scientific priority areas of this research centre, are: AI, software reliability and security and inter-disciplinary projects that are in particular in bio-info-health. [xxxi] The research centre has one department in e-health which is called "Digital Health, Biology and Earth". This department has two sub departments: "modelling and control for life sciences" and "computational neuroscience and medicine".

The sub department "modelling and control for life sciences" consists in turn of three teams. COMMEDIA is for example a research team that is engaged in the computational simulation of bio-fluid flows (of the cardiovascular system and respiratory system) in the human body. The two other teams are called INBIO and MAMBA.

The sub department "computational neuroscience and medicine" the team called ARAMIS is engaged in making algorithms, models and methods for images and signals of the human brain. [xxxii]

Paris Artificial Intelligence Research Institute (PRAIRIE)

PRAIRIE is one of the four institutes that emerged from an initiative of President Macron to create a small number of interdisciplinary AI research institutes, 3IA. PRAIRIE is one of the four selected institutes forming the 3IA and is located in Île-de-France and established in October 2019. The National Centre of Scientific Research (Centre National de la Recherche Scientifique, CNRS), Inria and the PSL (Paris Sciences et lettres) University joined forces to create the institute together with Amason, Criteo, Facebook, Faurecia, Google, Microsoft, NAVER LABS, Nokia Bell Labs, PSA Group, SUEZ and Valeo. [xxxiii] One of the PRAIRIE application domains is health and it will play a key role in research in different areas, notably:

- AI and biology: in various fields such as the use of deep learning for single-molecule microscopy and biologically inspired artificial neural architectures;
- AI and cognitive science: integrating AI techniques with social and cognitive sciences studies to obtain powerful predictive models of individual and collective human behaviour;
- AI and medicine: building advanced computer-aided decision and diagnosis systems for personalised medicine, including the evaluation, fairness, transparency and explicability issues.[xxxiv]

➢ REGION AUVERGNE-RHÔNE-ALPES

Analgesia
The Institut Analgesia Foundation is a centre for innovation in the field of pain management, big data and AI. This institute was created by the university hospital named CHU de Clermont-Ferrand. Together with Bepatient, Analgesia develops digital solutions for pain management. For example, the application eDOL is an e-health solution in personalised medicine. [xxxv]

Multidisciplinary Institute in Artificial Intelligence (MIAI)
MIAI is like PRAIRIE one of the interdisciplinary AI research institutes, 3IA, that is hosted by the university Grenoble Alpes. The aims of this project are to offer attractive courses for students and professionals of all levels, to support innovation in large companies, SMEs and startups and to inform and interact with citizens on all aspects of AI. The fifth of the seven axis of the institute is health. [xxxvi] The MIAI has three programmes:

- Real-life 4P medicine: This programme aims at demonstrating the citizens the relevance of new AI tools by exploring new challenges related to smart data capture, smart data fusion and new approaches for decision-making;
- Multimomics: Following the perspectives of developing new AI based tools for omics, this programme will focus on (1) the identification of new biomarkers from multimodal health data and on (2) the development of new tools to compute personalised risk scores, potentially leading to new medical practices.
- Computer-assisted medical intelligence: This last programme is dedicated to the development of intra-operative AI-based computerised assistants with the aim to treat patients more efficiently, less invasively, and have the ability to explain the decisions made.[xxxvii]

Institut national de recherche en informatique et automatique (Inria)
The research centre Inria Grenoble - Rhône Alpes was created in 1992 and has data science, technical, environmental and ethical reliability of software and quantum computing as scientific prioritory axis. [xxxviii] Like in Île-de-France, Inria has a research department in the region AURA that is called "Digital Health, Biology and Earth".
The sub department "modelling and control for life sciences" has two research teams that have slightly different focusses than in Île-de-France. The research team NUMED for example develops models to simulate the evolution of pathologies integrating heterogeneous data coming from different scales.
Besides, Inria Grenoble Rhône Alpes has four research teams in computational biology, BEAGLE, ERABLE, IBIS and MOSAI. ERABLE is an European research team in algorithms and biology, formal and experimental. The team IBIS make models, simulations, measurements and control bacterial regulatory networks.[xxxix]

2.2.2. Education

Nowadays, e-health in France is incorporated in education in several ways: entire masters and specialisations or university degrees dedicated to this topic exist. Besides, several initiatives are launched to introduce medical students to e-health. However, experts consulted for this report stated that e-health is not mainstreamed in the whole LSH education yet: some health(care) related universities are integrating e-health in their curriculum but this varies from institute to institute.

Below a non-exhaustive overview of the most relevant university programmes on e-health in Île-de-France and AURA.

➢ REGION ÎLE-DE-FRANCE

In 2016, École Polytechnique, HEC Paris and Université de Paris launched a master's programme to train the new generation of bio-entrepreneurs. The programme includes e-health, biotechnology and medical technology. The programme is taught in English and is in partnership with the Institute of Genetic Diseases, Imagine. Students work on real projects that could lead to the creation of companies with total immersion in the ecosystem of biomedical innovation.[xl]

Université de Paris has a Master's programme in Computer Science, which has a specialisation called "Security, networking and e-Health". This specialisation aims to train experts in the security of information systems and in new technologies in e-health and IoT.[xli]

Next to a master's programme and a specialisation, Université de Paris has a university degree in e-health of 70 hours which is designed for professionals. This degree is broadly oriented (from block chain to big data, from precision medicine to mobile health, from autism to nutrition and health) and is developed to gain understanding on the legal and ethical framework surrounding e-health on both societal and economic issues. [xlii]

L'École Polytechnique offers an innovation and health management programme, Innov'Health, for executives, managers, engineers and scientists. This programme focusses mainly on digitalisation and big data and is taught in French. [xliii]

Ilumens is a health simulation centre that trains (future) health professionals and is engaged in e-health E-learning and serious gaming. The simulation centre allows medical students to train in conditions that are very close to reality. Ilumens is established on three locations. Université de Paris has a simulation centre on two locations and the third centre is established in Université Sorbonne Paris Nord. [xliv]

➢ REGION AUVERGNE-RHÔNE-ALPES

Université Grenoble Alpes offers studies in biology, chemistry and health, as well as studies in big data, digitalisation and a master called "Artificial Intelligence & Web". [xlv]

The University of Saint-Étienne – Jean Monnet has various studies in LSH. With regards to e-health, the university has one master called "Machine Learning & Data Mining". This master has subjects like health informatics. [xlvi]

The Jean Moulin University Lyon 3 offers studies in the field human and social sciences and has a science technologies & health faculty. In the field of e-health the university has one university degree. [xlvii]

Université Savoie Mont Blanc offers several studies in the health domain. The study Data Science offers courses related to e-health. [xlviii]

2.3. Healthcare providers

This chapter will give a global overview and a non-exhaustive list of e-health activities of healthcare providers in the regions Île-de-France and AURA. The chapter is divided in three different categories: hospitals, hospital purchasers and care facilities.
E-health is evolving in various ways in the domain of healthcare providers. Platforms to strengthen the interoperability of systems are mushrooming. Next to improving the interoperability of systems hospitals are active in research, create tools, have e-health prevention initiatives and incorporate tele-health solutions (mostly teleconsultations, tele monitoring and tele-expertise).
Accommodation facilities for dependent elderly also showed to have activities in e-health in the domains interoperability of systems and tele-health.
All the aforementioned e-health developments are reflected by the markets that purchase organisations offer to hospitals and elderly houses.

In France, most hospitals and medical-social structures (retirement homes and specialised homes) are federated in the *Hospital Federation of France* (Fédération Hospitalière de France, FHF). The FHF includes more than 1000 public hospitals and 2000 medical-social structures. The role of the FHF fulfils a triple function: promoting its members by organising forums, informing professionals about the latest developments in healthcare and representing the institutions in different commissions such as the Higher Council of Hospitals (Conseil supérieur des hôpitaux, CSH). In the context of e-health and AI, the FHF ensures that the revolution in AI respects two major imperatives:

- equal access to technological innovation
- ensuring the protection of patients' personal data[xlix]

2.3.1. Hospitals

France has an extensive network of organisational initiatives to enhance collaborations between hospitals, such as the *Hospital University Centres* (Centres Hospitaliers Universitaires, CHU) and the *Hospital University Institutes* (Instituts Hospitalo-Universitaires, IHU). CHUs are public health institutions that have agreements with one or several universities. Region Île-de-France has one CHU and the region AURA has four CHUs. Besides the CHUs France has six IHUs, which are university hospital institutes based on R&D. Three IHUs are located in the region Île-de-France.
Below are listed in short the focus of these different CHU and IHN in both regions.

➢ REGION ÎLE-DE-FRANCE

Centres Hospitaliers Universitaires, CHU

Assistance publique – Hôpitaux de Paris (AP-HP)
Region Île-de-France counts one CHU: the Public Assistance – Hospitals of Paris (Assistance publique – Hôpitaux de Paris , AP-HP,) a major player in French clinical research federating 39 hospitals.
Known to be internationally oriented and being Europe's largest hospital structure, AP-HP integrates administrative and medical data of nearly 10 million patients.
One of most important e-health applications of the APHP is their data management system. To improve its data management, the AP-HP created the platform *Orbis*. This platform has several functions: it is a safety deposit box for healthcare data, patients can make appointments on the platform, pay online or fill in a questionnaire to facilitate the work of the doctor for the next consultation. As stated before in the chapter "The roadmap for digitalisation in healthcare", the patient records will be shared in all government facilities by mid-2020 and will be added to the nationally shared electronic health record "*dossier médical partagé (DMP)*" under the condition that the patient has created an account and has given permission to do so.[l]

The annual report of 2018 of AP-HP stated that it would like to further develop in specifically the following fields in telemedicine:

- Direct teleconsultations for patients integrated in a course of treatment for whom clinical examination is not needed;
- Indirect teleconsultations for non-autonomous patients (elderly, disabled, detainees etc.) accompanied by health staff;
- Tele-expertise;
- Tele-monitoring.

Another example of e-health application within the APHP federation the use of AI.
In the epidemiological clinic of the hospital l'Hôtel Dieu, AI is used in the epidemiology of chronic diseases in order to help public authorities to assess the effectiveness of the implemented health policies.[li]
The AP-HP hospitals Avicenne and Cochin use AI within the *Gi Genius*, an AI driven device to improve the early detection of colorectal cancer. [lii]

Instituts Hospitalo-Universitaires IHU

Institute of Cardio metabolism and Nutrition (Institut de Cardiométabolisme et Nutrition, ICAN)
The ICAN has e-health activities in the field of digitalisation of health data. *Integromics*, the bioinformatics team of ICAN, focusses on integrating patient's omics, clinical and environmental data. Additionally, the bioinformatics team is developing algorithms to improve omics data processing, visualisation, analyses and integration. [liii]

The Brain and spinal cord institute (Institut du Cerveau et de la Moelle Epiniere, ICM)
The ICM is an institute for nervous system diseases. The institute has an incubator, *iPEPS-ICM*, for startups in this field and hosts also startups developing e-health tools.[liv]

Institute for genetic diseases (Institut des maladies génétiques, IMAGINE)
IMAGINE, an institute for genetic diseases, created a tool, using AI; *Dr. Warehouse*. This tool is an open source data platform for clinical narrative reports and is designed to support the medical staff, research and the administration. is The software already in service in the Necker-Enfants maladies hospital of AP-HP from 2017 onwards. [lv]

Specialised hospitals

Gustave Roussy
Gustave Roussy is a European cancer centre located in region Île-de-France. It is a centre for patient care, research and education. An example of an e-health application at Gustave Roussy is a device that automatically outlines tumors and organs with the use of AI. This device is developed by the company TheraPanacea. [lvi]

➢ REGION AUVERGNE-RHÔNE ALPES

Centres Hospitaliers Universitaires, CHU
Region AURA has four CHU and all develop activities in the field of digitalisation in Healthcare as described below.

Hospices civils de Lyon (HCL)
The HCL is the umbrella body of thirteen health care establishments in the region of Lyon. The HCL has a big data system for patients called *Easily,* which is supported by Microsoft Cloud. Furthermore, patients of the Hospices Civils de Lyon have access to an administrative application called *myHCL*, an application to facilitate for example online payments.[lvii] [lviii]
The portal *Viapatient* is an extension of *Easily*[lix] and is dedicated to patients and healthcare providers. Two of the many services *Viapatient* offers are monitoring patients with chronic diseases at home (e.g. diabetic patients with a subcutaneous insulin pump) and the management of appointments.
Another e-health application within the HCL, launched in November 2019, is a programme dedicated to the prevention of autonomy loss for elderly people. This initiative consists of an

application that encourages a patient to fulfil their daily activities to maintain their normal lifestyle and to keep on exercising. Every time a patient has accomplished a challenge, the patient will be rewarded by points. The collected points can be used to buy for example cultural activities. The patients can be connected with other patients to contribute to their socialisation and to challenge the trend of loneliness amongst elderly people. [lx] [lxi]

CHU de Clermont-Ferrand
The CHU de Clermont-Ferrand created the research institute Analgesia, where AI and big data are used in order to reduce pain of patients (for more information see chapter 2.2.1 Research).[lxii]
Besides, the CHU uses AI during laparoscopic surgery with the help of the augmented reality software called *SurgAR*. [lxiii]

CHU de Grenoble
The CHU of Grenoble hosts one of the eight French centres for clinical investigation and technological innovation.[lxiv] An example of an e-health application of the CHU de Grenoble is the use of telemedicine for hart monitoring. [lxv]

CHU de Saint-Étienne
The CHU de Saint-Étienne has a virtual reality simulator for students to practice their competences on emergency cases. [lxvi]

2.3.2. Purchase organisations

In France, purchase organisations work on a national level and focus either on the public or the private sector. These purchase organisations mostly consist of lawyers, specialised in the purchasing sector and respecting the public procurement rules. Below the activities of four important French purchasing organisations are shown.

Réseau des Acheteurs Hospitaliers (RESAH)
RESAH is a purchasing organisation for the public sector. In 2018, RESAH proposed three software solutions in the field of e-health:

- A software solution for managing replacements of medical staff who are (last minute) not able to work;
- A national framework agreement for the coming four years for a software solution to schedule appointments online;
- Software enabling online voting for professional elections in health establishments.

In 2019 the software solutions were renewed and additionally three markets were launched to develop new solutions for: medical transport ordering, electronic document management to achieve a zero paper hospital and interoperability of systems.

A report of RESAH stated that teleconsultation and tele-expertise solutions in particular are very successful in France. [lxvii]

Union des Hôpitaux pour les Achats (UniHA)
UniHA is like RESAH a group purchasing organisation for the public sector and has likewise several markets in e-health. Examples of markets are digital dictation equipment, electronic patient record, recovery record and connectivity of biomedical equipment, specialised microcomputer materials, post processing of medical images, security of information systems, solutions for secure computer networks, storage, laboratory management system, telephony over internet protocol (TOIP) and server virtualisation. [lxviii]

L'Union des Groupements d'Achats Publics (Ugap)
The union of purchasing groups for the public sector, Ugap, is a state owned institution and has therefore a lot of commitment to public policies. Examples of some solutions that Ugap offers in e-health are:

- solutions for making medical appointments: e.g. confirmations and reminders through SMS and mail according to the pathology;
- software for managing the transmission of procedures, treatments and prescriptions from the patient's bedside to various stakeholders like health insurance organisations, the treating doctor etcetera;
- online games adapted for people suffering from cognitive disorders (Alzheimer, stroke, Parkinson);
- Various products to detect falls, reduce runaways and wandering;
- *Actitblue*, a device that produces sounds in order to help visually impaired people to position him or herself, give guidance and provide other information such as time.[lxix]

CAHPP
CAHPP is a purchasing organisation in the private sector. This purchaser is active in e-health for approximately one year and has various products in this sector in their assortment from different suppliers like *Hoppen, Axe Partner Santé* and **Medi'Pep**. Examples of e-health products that CAHPP offers are *MyHospiFriends*, a social network for patients, and *SmartBed*, a connected hospital bed to improve the patient's safety and comfort. [lxx]

2.3.3. Healthcare facilities

France has various national healthcare facility structures. One important facility structure is the accommodation establishment for elderly people (*Etablissements d'Hébergement pour Personnes Agées Dépendantes*, EHPAD).
Next to the EHPAD's, two other facility structures will be highlighted: CRIAS, a structure that promotes digitalisation in health care facilities and TASDA, a structure promoting home support.

EHPADs
An EHPAD is an accommodation facility for dependent elderly people and very dependent people suffering from chronic pathologies. EHPADs have various innovative developments in different fields of e-health, a few examples will be shown below to illustrate this:

- The platform *ViaTrajectoire* is an example of a development in the field of interoperability of systems. *ViaTrajectoire* accompanies elderly people in the orientation and subscription for a nursing home and simultaneously transfers the health data of this person to the nursing home;[lxxi]
- The cloud service operator company *Foliateam* works together with 400 EHPADs to improve patient care, while increasing the efficiency, quality and working comfort of the staff. To host the data Foliateam has a partnership with the in AURA situated company, SynAAps. More information about Foliateam and SynAAps can be found in the chapter "industry"; [lxxii]
- An example of a tele-health service that is in use in EHPADs in Île-de-France is called *TokTokDoc.* This is a service that enables elderly people to have remote consultations with their doctor; [lxxiii]
- The robot *Medi'Pep* is in use in several EHPADs in Île-de-France. The in Île-de-France located company Aldebaran robotics initially designed the robot. Aldebaran robotics is nowadays called SoftBankRobotics and is an international company that expanded to Asia and the US. [lxxiv] The robot was adapted by the in Île-de-France based company Spin'R to be used in medico-social establishments. *Medi'Pep* is designed for monitoring people's health, especially of elderly, dependent or disabled people. Some features of this robot are advanced language recognition skills, facial and object recognition, monitor the inhabitants (reminder of the hydration and disinfection guidelines). In order to improve interaction and recognition of emotions, the collected data is shared in a cloud-based AI system. [lxxv, lxxvi]

Regional information centre for solidary action (*Centre Régional d'Information pour l'Agir Solidaire*, CRIAS)

CRIAS is an association based in AURA working in the fields of gerontology, disability and loss of autonomy. This association aims to inform, do research, coordinate, train and promote social action in favour of elderly people, retired or pre-retired people with disabilities. CRIAS provides professionals and students in the medico-social sector with services and resources to support and guide them to improve health(care). CRIAS hass one demonstration showroom called ELSA. As a prototype of a futuristic elderly care residence, ELSA demonstrates among others how digitalisation can be used to improve the home care system. [lxxvii]

Technology cluster Alps for home healthcare and autonomy (*Technopôle Alpes Santé à Domicile et Autonomie,* Tasda)

As an expert in the use of digital tools for home support, Tasda gathers all stakeholders in this domain. This association stimulates the integration of digital devices in the care residences located in AURA by offering for example assistance on collaborative projects to test new solutions for home support.[lxxviii] In order to promote innovations, Tasda set up a catalogue, called DOM'inno, with digital solutions in homecare (of which more than 250 in e-health products) that can be bought or hired. [lxxix]

2.4. Industry

La French Tech stated in 2019 that France is 2nd in Europe in the field of fundraising and the fast growing companies in the technology sector in general.[lxxx] France has more than 600 SMEs in health tech domain. [lxxxi]
A study about those health tech companies in France performed by France Biotech and published in 2019, identified the typology of health companies with less than 250 employees. The conclusion was that 7% of them are positioned in the e-health market in particular.[lxxxii] Expectations are that this percentage will increase in the coming years.

The following part of the chapter will illustrate a non-exhaustive list of the main national and international companies that develop activities in e-health in Île-de-France and the region AURA respectively.
These companies are classified in the three themes, based on the e-health domains as described in the chapter "introduction to e-health": (1) interoperability of systems and (2) tele-health. Besides, a special subdivision (3) medical imaging is made because particular opportunities in this field are expected. Sometimes a product or service could be subdivided in more than one domain. In this case, it will be classified in the best fitting domain.

Many companies in France decided to focus on e-health, which also includes international companies (such as Philips, Gemalto, Roche and Siemens) and the strong pharmaceutical industry. From the companies mentioned below, it can be seen that companies in both regions are active in interoperability of systems and tele-health. Mainly in the region Île-de-France many companies focus on the domain medical imaging.

2.4.1. Region Île-de-France

Many national and international companies start focusing on e-health in this region. This includes top pharmaceutical companies in Île-de-France such as Sanofi, Servier and Pierre Fabre.
However, this is not the case for every sector. An analysis is performed on the pipeline of the nine most important French biotechnologies and medical technologies in Île-de-France in combination with the number of patients that they could treat by 2030 based on a report of the Boston Consulting Group. [lxxxiii] Performed desk research showed that none of these main biotech and medtech companies were found to currently have major activities in the domain of e-health.
The following text gives a non-exhaustive list of companies in the region and elaborates on some of their major activities in France.

(1) Interoperability of systems

Foliateam

The company Foliateam is a communication integrator and operator for businesses and has a health department called Foliateam Healthcare. This department offers services in communication, security and data hosting. It has a partnership with the in the region AURA based company SynAAps which has a certified health data centre. [lxxxiv]

Gemalto

The international digital security company Gemalto participates in more than 100 French government programmes. One of their products is the electronic insurance card system of the Carte Vitale (the French health insurance card). Next to the Carte Vitale they provide services for the Dossier Médical Personnel (DMP) and the Pharmaceutical Dossier (PD). [lxxxv, lxxxvi]

Groupement de Coopération Sanitaire Service Numérique de Santé (GCS SESAN)

GCS SESAN is an independent non-profit private organisation that works in collaboration with the Regional Health Agency of Île-de-France to develop health information systems. They lead many projects of which *ORTIF* , a telemedicine platform in Île-de-France that uses different forms of telemedicine: tele-expertise, teleconsultation, remote assistance and tele

monitoring. From the opening of the platform in 2014 on, 186 health establishments implemented this platform. [lxxxvii]

Orange

The French telecommunications company Orange has with more than twelve year experience in e-health reinforced its e-health strategy in 2018 with the acquisition of Enovacom, a software editor dedicated to healthcare, and produces tools to:

- enhance data sharing between health facilities;
- increase the confidentiality of this data by securing access;
- exploit medical information to engage in big data and predictive medicine.

Additionally, Orange facilitates the hosting of personal health data in a private, public or hybrid cloud.[lxxxviii]

Philips Healthcare

In the field of interoperability of systems, Philips Healthcare has developed a cloud-based platform called *HealthSuite*. Within this platform clinical and other data from various devices and sources (e.g. medical records, imaging, monitoring data, personal devices) are collected, correlated with each other and analysed.[lxxxix] Besides, Philips Healthcare plans to contribute to improvements in the interoperability and patient pathway in hospitals.[xc]

Roche

The activities of the international company Roche in France are centred on the development of treatments for pathologies for which the medical needs are not yet satisfied such as cancers, multiple sclerosis, haemophilia and others. With regard to e-health, the international company Roche focusses in the period 2018-2020 on putting the health data at the service of the patient and has strategically decided to improve their expertise in cancer and molecular information with the ambition to achieve precision oncology. Roche France initiated within this framework the programme *Epidemium*.[xci]

Sanofi

The pharmaceutical company Sanofi has opened an e-health laboratory in 2017 called *39BIS*. This laboratory is in particular oriented to projects in:

- Correct use of medicines;
- Vaccination;
- Diagnostic errors in rare diseases;
- The role of the pharmacist and the diagnosis of skin disorders. [xcii] [xciii]

Laboratory *39BIS* develops among others connected services and platforms for pharmacists.[xciv] One example of a platform that is developed by Sanofi is *DARWIN*, a global collaborative platform that brings together a wide variety of health data covering more than 345 million patients, 218 diseases and 48 clinical studies. The platform aims to reduce drug development costs substantially. [xcv]

Voluntis

The digital therapeutics company Voluntis uses patients health data to improve medication or medical devices. Until now Voluntis has developed software for diabetes, respiratory diseases, cancer, anticoagulation and haemophilia. [xcvi] Voluntis is among others active in the area of interoperability of systems and has a modular cloud based platform Theraxium oncology.

(2) Tele-health

BEPATIENT

The team of BEPATIENT has developed an e-health platform for hospitals and health professionals. It has four products in e-health, one on prevention, one on hospitalisation, one on chronic care and one that supports patient participation in clinical trials. [xcvii]

Medtronic and International Business Machines Corporation (IBM)

Medtronic is an international company specialised in medical technology and has next to the headquarter and a technical support office located in Île-de-France, also two production sites in the region AURA. In collaboration with the international IT company, IBM, it developed the application *SUGAR.IQ* for diabetic patients that uses the real time glycaemic index to analyse the daily glucose patterns and identify the activities that affect them. [xcviii] [xcix]

Health for Development

An e-health innovation which marked France is a product called *Consult Station*, a product from the originally French company Health for Development (H4D). The *Consult Station* is a tele-health cabin with a multiplicity of measuring instruments, in which it is possible to have a teleconsultation or simply a health check-up with the use of an intuitive video tutorial. The consult station is CE-certified and has also been approved by the French Regional Health Agency (Agence Régionale de la Santé, ARS) and French Data Protection Authority (*Commission Nationale de l'Informatique et des Libertés*, CNIL).[c]

Sanofi

In diabetes, the e-health laboratory of Sanofi, *39BIS*, has developed several telemedicine solutions like mobile applications. In the field of rare diseases and tele-education, *39BIS* has for example developed *Socrate*. this is a serious game which offers general practitioners a series of clinical cases where they must identify weak signals of a pathology.

Sanofi and Google

Next to the e-health laboratory, Sanofi has been investing for three years in a type 2 diabetes joint venture with Verily Life Sciences, a research organisation owned by Google. To goal is to make a virtual diabetes clinic, *Onduo*, to combine the knowledge of verily in miniaturised electronics, analytics and consumer software with the knowledge of Sanofi on diabetes. The virtual care programme aims to support the diabetes management by using compatible blood glucose meters and continuous glucose monitoring systems.[ci,]

Sanofi and Voluntis

Sanofi and Voluntis created together a tele surveillance application called *Diabeo*. This is a mobile application which calculates the required real time doses of insulin, tailored to the diet and physical activity and all based on their doctor's prescription. *Diabeo* is the first digital medical device in France that is assessed and even reviewed favourably by the High Autorithy of Health(Haute Autorité de santé, HAS) in 2016.[cii] The application obtains support from the governmental programme "*Expérimentations de Télémédecine pour l'Amélioration des Parcours En Santé*" (ETAPES), an experiment which promotes and financially supports the deployment of projects in tele monitoring. [ciii]

Servier and Bioserenity

The French pharmaceutical company Servier has an e-health department called *We-health Digital Medicine*. This department co-develops products and services in e-health focalised on personalised medicine, prediction and prevention. Two examples of tele-health products are *Cardioskin* and *Deprexis*. Servier develops *Cardioskin*, a portable and wearable electrocardiogram, in collaboration with a medical device company, Bioserenity. Together with a mobile application where the patient can add his or her related symptoms it monitors the cardiac activity. The device eventually enables the cardiologist to discover correlations. *Deprexis* is an online cognitive-behavioural therapy which provides tailored therapeutic support to people suffering from a depression.[civ] [cv]

Voluntis

Next to the area interoperability of systems, the digital therapeutics company Voluntis is also active on the field of tele-health.[cvi] Voluntis is for example active on the domains personalised medicine and therapeutic education and coaching messages that change behaviours and help patients to take an active role. [cvii]

Withings

The French company Withings (formerly Nokia Health) produces connected health devices and applications to empower people to make health decisions. The company is the first in the world that launched a Wi-Fi scale in 2009. Next to this, Withings makes hybrid smartwatches and products to monitor health like blood pressure, sleep and body temperature. Through the *Health Mate* application people can track their progress and share data with their doctors. [cviii]

(3) Medical imaging

Canon Medical Systems

Canon Medical Systems offers a wide range of products in medical imaging. *Aquilion ONE GENESIS,* a CT scan that uses AI developed by Canon Medical Systems is for example used in a French hospital since the beginning of 2019. The technology improves the quality of the obtained images without affecting the duration of the examination. [cix]

GE healthcare

GE healthcare offers, within the framework of data integration, regional image exchange services in France. [cx]

Incepto Medical

Incepto Medical co-creates AI based applications for medical imaging which is linked to one single platform to enable tele-expertise. [cxi]

Owkin

Owkin is a company that integrates biomedical images but also genomics and clinical data by using AI and machine learning to improve medical and biological research. [cxii]

Philips Healthcare

Philips Healthcare is very active in France in the field of medical imaging. One innovation of Philips in this field is *Illumeo*. This software tool aims to improve the efficiency of physicians by using adaptive intelligence that interacts with imaging data. From 2019 to 2021, *Illumeo* is being validated clinically in a CHU in France.[cxiii] The software of *Illumeo* integrates with systems such as *IntelliSpace*, another example of a solution being implemented in France. [cxiv] In 2019, a French hospital and Philips signed a 10-year enterprise informatics agreement to implement the advanced visualisation platform solution called *IntelliSpace Entreprise Imaging*. [cxv]

Sanofi

Next to being active on the fields of interoperability of systems and tele-health *39BIS* entered a partnership to build a collaborative platform on imaging and data of skin disorders. [cxvi]

Siemens Healthineers

Siemens healthineers is the health department of the international electronics company Siemens. This department develops solutions on therapeutic imaging and laboratory diagnostics.[cxvii] Examples of products of Siemens Healthineers, that are in use in France, use Magnetic Resonance Imaging (MRI) techniques: *IRM 3 Tesla* and *IRM 7 Tesla*. These MRI products are directly connected to both the operating room and the clinical environment. This makes it possible to have pre- and intraoperative image acquisition and which provides insight into the amount of postoperative tumour residues. [cxviii]

Therapixel

The software company Therapixel is specialised in AI applied to medical imaging in two domains: the operating room and radiology. [cxix]

TRIBVN
TRIBVN Healthcare develops AI based software solutions for digital pathologies to enable the management, analysis and sharing of cellular images both for diagnostic laboratories and pharmaceutical & biotech manufacturers.[cxx]

Next to interoperability of systems, tele-health and medical imaging, companies based in region Île-de-France do also have other activities in the domain e-health. Some interesting examples are given below.

Cardiologs
The medical technology company Cardiologs develops products to transform cardiac diagnostics by utilising AI and cloud technology. The Cardiologs ECG Analysis Solution is based on a database of more than 1,450,000 recordings and was the world's first medical device powered by the technology deep learning that has received regulatory clearance (CE Mark) in 2016. [cxxi]

Google and DeepMind
Google joined forces with DeepMind, an international company with a location in Paris. DeepMind Paris has expertise in the use of AI for diagnostics of eye diseases and prediction of complex 3D shapes of proteins. [cxxii]

Philips Healthcare
Philips Healthcare is currently focusing on health technology and opened an R&D lab in AI and health in April 2018. The lab focusses on three clinical domains: cardiovascular diseases, oncology and rare disease. In these domains the focal points are on genomics, medical imaging and the development of startups of la French Tech. [cxxiii]

Pierre Fabre, Keyrus and Microsoft
The pharmaceutical company Pierre Fabre partners with among others Keyrus and Microsoft to set up a European observatory in southern countries on e-health. The aim of this observatory is to perform an analysis of e-health initiatives in African and Southeast Asian countries to document, promote and help develop e-health initiatives in the most resource-limited countries. Microsoft focusses specifically on the domain AI.[cxxiv] [cxxv]

2.4.2. Region Auvergne-Rhône-Alpes

Like for the region Île-de-France, an analysis is performed on the pipeline of the four most important French biotechnologies and medical technologies based on a report of the Boston Consulting Group. Four companies turned out to be established in the region AURA. Following desk research one of these companies, Transgene, turned out to have activities on the field of e-health.

The following text will give a non-exhaustive list of large companies in the region and elaborate on some of their major activities in France.

(1) Interoperability of systems

Agatha
Agatha is an international company that provides software solutions provider to the health care and life sciences industry. The intelligent content management clouds of this organisation permits data exchange between multiple establishments. Examples of Agatha's clients are hospitals, pharmaceutical companies and clinical research organisations. [cxxvi]

DataMedCare
DataMedCare develops digital tools to meet the challenges of chronical diseases and develops among others tele-health platforms that collect data and improve interoperability. [cxxvii]

Eveon

Eveon is specialised in preparation and automatic delivery of therapeutic treatments by using digital tools to produce medical platforms to treat the patient. [cxxviii]

Microsoft

In the region AURA, Microsoft collaborates with *Hospices Civils de Lyon* and uses big data, AI and a cloud called Easily to develop a patient information platform that transfers patient details from one hospital to another.[cxxix]

Orange

Almeryes is the branch of Orange located in AURA. Almeryes is active in big data, especially in the field of health and dematerialisation of transactions. The specialisation of the branch is simplification of the management of health reimbursements. [cxxx]

SynAApS

SynAApS, already referred to in previous chapters, is a certified cloud computing company that also offer services to host health data as mentioned in previous chapters.[cxxxi]

Maincare Solutions

The French organisation Maincare Solutions has R&D sites in Lyon and Grenoble. It delivers IT solutions dedicated to French healthcare establishments to improve the management of the patient's journey (admission, transfer, resource planning, patient's medical records and prescriptions) throughout the entire hospital. Besides, Maincare Solutions offers solutions in the management of administration and medico-economic assessments. Nearly 310 hospitals, of which 80% are French CHUs/regional hospital centres, already make use of one of Maincare Solutions' products. [cxxxii]

(2) Tele-health

Bioserenity

The medical device company Bioserenity uses AI and big data to take care of patients by using a telemedicine platform. The company for example develops connected medical clothing. [cxxxiii]

DataMedCare

Besides being active in the domain of interoperability of systems, DataMedCare develops digital tools in tele-health. [cxxxiv]

Diabeloop

Diabeloop developed an external medical device for diabetics called DBLG1 System that controls the blood glucose and sends the results to the system via bluetooth. This system analyses the data by using artificial intelligence and calculates the right dose of insulin that is needed. [cxxxv]

Orange, Covalia and Almeryes

Espace Télémédicine Auvergne (ESTELA) is a teleconsultation platform exclusively available in the region AURA. This platform provides teleconsultations on several medical areas of cooperation such as neurology (treatment of strokes in emergencies e.g.), geriatric in EHPAD, cancerology, dermatology and more. Orange, Covalia and Almeryes take part in the consortium. The French company Orange is in charge of the project management and network. The computer software company Covalia is in charge of the file and video management tools and Almeryes is responsible for the telemetry part.[cxxxvi]

(3) Medical imaging

Maincare Solutions

Maincare Solutions offers, next to many solutions for the interoperability of systems also solutions in the management of medical imaging . One system the company offers is called *PACS Change Healthcare Radiology Solutions*. [cxxxvii]

Next to interoperability of systems, tele-health and medical imaging, desk research showed that companies in region AURA also have other activities in e-health. Some interesting examples are given below.

Atos
In 2021 Atos, an information technology service and consulting company, will open a campus dedicated to artificial intelligence close to Grenoble. [cxxxviii]

Hitachi
The international IT company Hitachi recently announced a partnership with the Centre Léon Bérard, a research centre and hospital specialised in cancer. The so-called Hitachi Lyon Lab focusses on AI and cancer.[cxxxix]

Fluoptics
Fluoptics is a medical company that develops surgical equipment by using the latest technologies, including data and AI.[cxl]

Thuasne
Thuasne is a medical orthopaedic company using numerical data including AI. [cxli]

Transgene
Transgene uses artificial intelligence algorithms for its *Myvac* products that stimulate a patient's immune system against cancer. [cxlii]

Pfeiffer Vacuum
Pfeiffer Vacuum uses data algorithms to predict the performance of their products. One of its products is a pace maker for the heart. [cxliii]

2.5. Support for startups

France is reported to be first in Europe in the amount of companies that created a lab, incubator or accelerator.[cxliv]
The strong startup culture is reflected in the amount of incubators, accelerators and investors that are present in the region Île-de-France and the region AURA. World's largest startup campus, Station F, is for instance based in Île-de-France and the region AURA is home to many startup programmes thanks to its rich ecosystem.

In the field of health in general, StartUp Health Insight stated that startups in Paris raised 394 million dollars funds in the third quarter of 2019, making it the second most-funded non-U.S. health hub in that period.[cxlv] Besides, in 2018 Paris was, with a total of 245.5 million euros raised, the most attractive metropolis outside the United States in terms of e-health investments.[cxlvi]

Looking into the e-health startups in France, a report of the French Health Tech showed that half of the startups of their members were based in Île-de-France. The other half were spread throughout the national territory.[cxlvii] This shows that this region is particularly interesting for e-health startups.

An example of a in France well known e-health startup that became a unicorn is Doctolib, an online and mobile booking platform that helps to find a doctor or specialist nearby and facilitates making an appointment. One of the reasons why the application Doctolib evolved this rapidly in France is that in France there is no need of a doctor to be referred to a specialist.

This chapter will highlight three important stakeholders in the support for startups in in the regions Île-de-France and AURA: incubators, accelerators and investors.

2.5.1 Incubators

Desk research has shown that various actors incubate e-health startups in France. Next to the classic incubators, also hospitals and research centres show to incubate e-health startups. Below is given a short list of the important e-health incubators in regions Île-de-France and AURA.

➢ REGION ÎLE-DE-FRANCE

In the region Île-de-France, Paris Biotech Santé has an incubation programme specialised in innovation in healthcare, called Box innov santé. This programme focuses in accompanying projects in the development of drug medical devices and innovative services for the benefit of patients. The Box innov programme is based on three pillars: 1) Strategic coaching, 2) collective coaching and 3) working space and lab access. [cxlviii]

A selection of more general startup incubators with e-health programmes are the following:

- Agoranov
  Agoranov is one of the most important tech incubators in Paris and an expert in deeptech that supports projects in among others the fields digitalisation and health. [cxlix]
- Biocitech
  Biocitech hosts national and international companies of all sizes, including startups. This incubator houses companies which are dedicated to healthcare, biotech or environment. Biocitech, offers (technical) support in imaging, medical devices, diagnostics and other services.[cl]
- Paris & Co : Tech Care Paris
  Paris&Co is an internationally oriented incubator with various startup incubation programmes. *Tech Care Paris* is the e-health, wellbeing and medtech incubation programme. The *Tech Care Paris* programme offers a one or two year programme for startups working on projects in data collecting, hospital performance, patient experience, elderly care and many others. [cli]
- Station F
  Station F has many startup programmes in different fields. Examples of programmes in the field of e-health are *iPEPS-ICM* and *Microsoft AI Factory*. *iPEPS-ICM* is a programme that is

coordinated by the Brain and Spine institute and develops projects in digital health. *Microsoft AI Factory* is dedicated to the development of AI, among others in health.[cli]

Also hospitals work closely with startups to develop their businesses. An example is Paris Santé Cochin, a programme animated by Paris Biotech Santé. With 23 businesses located in the Paris Santé Cochin, it is the biggest healthcare nursery in Europe. One of their four business areas is e-health and mobile applications. [cliii]

➢ REGION AUVERGNE-RHÔNE-ALPES

Next to the high amount of incubators in general, the region AURA has incubators in the e-health domain.

One on these incubators is Busi. Busi incubates and guides companies in both the implementation phase and the pre-implementation phase (strategic, scientific, economic and juridiciairy assistance). Three of the four strategic lines Busi defined are LSH, engineering (robotics) and ICT. [cliv]
Lyon's largest incubator, H7, will be officially opened in May 2020. This incubator will guide startups in the digital sector, including health and has partnerships with various companies and organisations. One example of a partnership is iExec, a company providing a block chain-based decentralised marketplace for cloud resources. As a partner of H7, iExec provides the incubator of expertise in the field of blockchain. [clv]
The research centre INRIA supports the creation of startups from public research in digital deep tech with the creation of its startup studio in 2019. In the region AURA situated research centre incubated, in collaboration with the incubator Empowered Startups France, health companies with activities on AI. [clvi]

2.5.2 Acceleration programmes

Many organisations in France offer acceleration services to startups in e-health. Not only classic seed accelerators but also companies, investment banks and research centres. A few examples of acceleration programmes in the regions Île-de-France and AURA are shown below.

➢ REGION ÎLE-DE-FRANCE

- AI factory for health
  Microsoft and AstraZeneca founded in collaboration with INRIA, the national research institute for digital sciences, the AI Factory for Health, a three months accelerator programme. This initiative helps early-stage startups with their developments in AI and cloud computing. [clvii]
- Le Hub Healthtech
  The investment bank Bpifrance has Le Hub Healthtech that is a hub that helps startups getting on the French market. It guides among others startups in e-health and has an partnership with Roche and Sanofi.[clviii]
- Digital pharma lab
  Digital pharma lab is a pharmatech accelerator supported by Bpifrance and officially launched in December 2019. [clix, clx]
- Philips AI expertise centre
  Philips will open a centre of expertise in AI, dedicated to medical imaging, genomics and the ecosystem of French startups. The main themes are cardiology, oncology and rare diseases.[clxi, clxii]
- Matrice Santé & Numérique
  The combined strengths of pharmaceuticals and diagnostics under one roof have made Roche expert in personalised healthcare. Roche is mentor of startups in e-health and launched Matrice Santé & Numérique which brings together various stakeholders in e-health. This initiative already created five e-health projects. [clxiii]

➢ REGION AUVERGNE-RHÔNE-ALPES

- Big Booster
  The accelerator Big Booster supports early stage startups (that have a proof of concept or a prototype) that have the ambition to develop internationally. The programme focuses on three areas: bio & health (including e-health), IT and global impact. [clxiv]
- Synapse
  Synapse is a programme that emerged from the partnership between the incubator network and seed accelerator 1Kubator, and the international pharmaceutical company, Boehringer Ingelheim. The programme aims to guide startups in the domain of e-health, both in human and animal health. [clxv]

2.5.3 Investors

Both regions Île-de-France and AURA are home to many investors. Some of them are specialised in financing health tech programmes, others have a broader programme and a special focus on health tech. Below you will find a selection of both type of investors, a more extensive list can be found in appendix 4.

➢ REGION ÎLE-DE-FRANCE

Health tech investors

- IDinvest Partners
  IDinvest Partners is experienced in financing high-growth companies in the healthcare sector and focusses on new medications, treatment processes and diagnoses in biotechnology, healthcare and nutrition. It has a partnership with Kurma Partners. [clxvi]
- Innovation Capital
  Innovation Capital is an international venture capital firm that invests in information technology and healthcare services and has a sector fund that supports the silver economy. The firm invests in both early and later stage companies. [clxvii]
- Kurma Partners
  Kurma Partners finances innovations in the healthcare and biotechnology sector (with a focus on rare diseases and diagnostics), from pre-seed to growth capital. Besides, Kurma manages healthcare investments of the Paris Saclay Seed fund, mainly on diagnostics and digital health. [clxviii] The Paris Saclay Seed fund is an investment fund led by students and alumni from the university Paris-Saclay [clxix]
- Omnes Capital
  Omnes Capital is a venture capital firm with the two target sectors tech and health and focusses on the themes digital (advanced software), deep-tech (big data) and life sciences (biotech, med-tech and diagnostics). [clxx]

Investors with health tech programmes

- Partech
  Partech is a global venture capital firm and invests in internet and information technology startups at seed, venture and growth stages. Partech also manages healthcare investments of the Paris Saclay Seed fund, which is an investment fund led by students and alumni from the university Paris-Saclay. [clxxi]
- Sofinnova Partners
  Sofinnova Partners is an independent venture capital firm. It invests in startups, early-stage companies, corporate spin-offs and occasionally turnaround situations in the theme life sciences (Biopharmaceuticals, biotech, medical devices, and industrial biotechnology).[clxxii]

➢ REGION AUVERGNE-RHÔNE-ALPES

Healthtech investors

- **MM Innov'**
  MM Innov' is an investment funds that is part of the large Malakoff Médéric company. MM Innov' is created with the aim to support startups in the fields of health, e-health and fin tech with its financial resources. Malakoff wants to collaborate with startups in: (1) Health, (2) Human resources (3) Insurance and (4) social and societal engagement (disability, caregivers, cancer)[clxxiii, clxxiv]
- SEB Alliance
  SEB Alliance is an investment department of the Groupe Société d'Emboutissage de Bourgogne (Groupe SEB), a French consortium that produces small appliances. SEB Alliance invests in the fields wellbeing (e.g. ageing), worldwide connection (IoT, Robotics & digital service applications) and sustainable development. [clxxv]

Investors with health tech programmes

- Angelor
  Angelor is a company active on the investment market. Angelor invests in promising projects of startups and connects these startups with other (private) investors. One of the focusdomains of Angelor are innovative companies in the health sector. [clxxvi, clxxvii]

PART III OPPORTUNITIES

Throughout Part I and Part II of this report, we set out the landscape of digitalisation and e-health in France, with a particular focus on the regions Île-de-France and AURA. These chapters were aimed at elaborating on the French ecosystem and providing Dutch researchers, entrepreneurs, foundations and public authorities with a helicopter view on the dynamics in this ecosystem. Before drawing some conclusions it is worthwhile highlighting some opportunities for both broadening and deepening opportunities for bilateral cooperation, including the role an Embassy and the agency RVO can play in materialising these opportunities. In order to do so, this part first provides the reader with a summarised mirror image on digitalisation and e-health in the Netherlands.

3.1. E-health in the Netherlands

Policy

Recently the Dutch Government defined four major societal *missions* within the frame of its newly established mission driven innovation policy. Public-private consortia are set to contribute through R&D and innovation in providing sustainable solutions for these missions. One of these major missions is Health & Care.[1] These missions are characterised by long term objectives and are generally well targeted. Public-private partnerships, including civil society, are committed in achieving these objectives. In this context it is worthwhile noting that, especially in the field of health & care one no longer talks about the triple helix but rather the quadruple helix. Aimed at achieving these societal missions, on 11 November 2019 government, research institutes, industry and foundations/associations signed an agreement committing themselves to invest €4,9 billion per year until 2023 in public-private partnerships in the fields of R&D and innovation.

Life Sciences & Health / mission health & care

Taking a closer look into the global objectives within the mission health & care, one distinguishes four targeted so-called sub-missions :

1. In 2040, diseases due to lifestyle or an unhealthy environment, will have diminished by 30%;
2. In 2030, health care delivered within the habitat of patients will have increased by 50%, taking into consideration the (social) network of each individual;
3. In 2030 the rate of participation within Dutch society of people affected by chronic diseases or lifelong limitations will have increased by 25%;
4. In 2030, the quality of life of people affected by dementia will have increased by 25%.

Obviously, further digitalisation in health & care has the potential to contribute significantly in achieving these objectives within the set timeframe. In addition, considering the similarities in policy objectives between France and the Netherlands, it will be increasingly interesting to join forces in addressing these challenges.

Ambitions in E-Health

Like in France, stakeholders in the health & care sector in the Netherlands are convinced that an important part of health & care will gradually and increasingly shift to the neighbourhoods in which citizens live, even to their homes. Such a shift obviously requires a lot from health & care personnel at all levels, including hospital directors. Moreover digital health & care, is strongly believed in the Netherlands to hold the potential of putting the patient at the centre, more than ever before, and at the very core of every health & care experience.

[1] The other missions being Energy transition & sustainability, Agriculture, water & food, and Security. A fifth, transversal, mission was added, being key enabling technologies.

This explains why already in 2013 the Ministry of Health, Wellbeing and Sports established three targeted objectives for a five-year period, covering 2014-2019.[2] On 1 November 2019 the last monitoring report of this five year period was submitted to the responsible minister, whom, in turn, informed Dutch parliament on progress made. Over this five-year period significant progress was made in the field of online consultation of medical files, in particular among hospitals and general practitioners. Moreover, an important percentage of chronically ill applied self-measurements, whereas an almost equal percentage remained reserved. However, the number of video calls decreased within hospitals and among the elderly. At the same time, an increase in contacts through apps was noted and surveillance techniques (domotics) are assessed by patients to be increasingly useful for patients (in particular the elderly) and to hospitals. This shows the dynamics of developments in digitalisation in health & care and the importance of putting the patient at the centre. Despite progress made, barriers impeding the application of digitalisation in its full potential are being reported by healthcare providers as well, such as internal procedures not being adapted to a digital environment and administrative burdens due to duplication of information & communication technologies. A strong impulse is therefore needed aimed at accelerating optimal use of digital health & care. [clxxviii]

Interoperability of systems

Like in France with, for example, its Health Data Hub, the Netherlands is strongly investing in health data infrastructure and the interoperability of data systems. The Dutch national government is investing about 500 million euro in a series of programmes to make health data available in a standardised digital form. Through safe and trusted interfaces. These incentive programmes are health-sector specific, starting with academic hospitals, general hospitals, general practitioners, social and long-term care facilities, specialised clinics, mental healthcare and pharmacies. Additionally, a national coalition of patients, payers, providers and government created a national trust framework for safe and trusted use of personal health data services called MedMij. And with the Dutch leadership in the international coalition on health research infrastructure Health-RI, privacy-respecting secondary use of personal health data for research purposes is also possible, using the Personal Health Train concept. These hold an interesting potential for cooperation with French counterparts, including in a wider European context. The fact that already 91 % of patient records are digitised in the Netherlands (being the highest percentage in Europe)[clxxix], makes it an interesting partner to work with on medical data and the interoperability of health data infrastructure systems.

E-health awareness

Our desk research combined with expert interviews made it clear that digital awareness raising within all layers of our society is of paramount importance in order to reap the full benefit of e-health, ranging from adapting curriculum in education to stimulating skills developments among all age categories across all socio-economic classes. In this context it is worthwhile mentioning that the Netherlands, for the fourth consecutive year organised end January 2020 the National e-health Week. During a whole week in the entire country, hundreds of events were organised by hundreds of partners (enterprises, foundations, suppliers, patient federations, municipalities, education and training institutes, research organisations, insurers, ministries, etc) providing for new insights to all stakeholders, in particular the end users.

Medical imaging

Over the past years, the Netherlands has been developing a strong position in medical imaging, putting it on the forefront in the international scene. Of course, Philips has been a big driver for this, as well as a magnet for talent in medical imaging. A recent example of this expertise is the opening of a new imaging centre by the Medical University Centre of Amsterdam, specialised in oncology and neurology (Parkinson, MS, Alzheimer). This position stimulates the strengthening of an ecosystem,

[2] 1. In 2019, 80% of chronically ill people have direct electronic access to some of their medical data, such as medication, vital functions and results of exams, and can use them in apps on their portable phones or internet applications. 2. Of the chronically ill (diabetes, COPD) and vulnerable aged persons 75% will be able to proceed with self-measurements in 2019, combining with distance monitoring by a health professional. 3. In 2019 all of those in need of home care will be able to communicate remotely with their professional health-aid, 24h a day. In addition, smart home technology will be used to support home care.

comprising both research institutes, hospitals and enterprises, including cooperation with French stakeholders.

Digital (health) technologies

Both France and the Netherlands are strengthening their expertise in the fields of AI and blockchain applied in health & care. For instance, the Dutch authorities did a pilot to get hands-on experience of the value of using blockchain technology in healthcare processes, with an application called *Mijn Zorg Log*. Moreover, the Netherlands holds a strong position in AI & health in the fields of deep learning, robotics and natural language processing. This explains why concrete plans are being established aimed at setting up a Health Tech Campus comprising a focus on AI. Such developments favour bilateral cooperation, including setting up partnerships within the framework of European R&D&I programmes, in particular Horizon Europe, building upon the strong ties created during the implementation of Horizon 2020.

3.2. Opportunities for bilateral cooperation

France and the Netherlands share a great variety of societal challenges when it comes to digitalisation in health & care. Think of the ageing population, increase in chronic diseases and health inequalities. As both countries spend more than 10% of their GDP on health & care, both France and the Netherlands are expected to further stimulate the development and use of digitalisation in order to curb (rising) costs in health and care. This provides for various means of both widening and deepening the existing collaboration, also in a wider European context. Some of these means are highlighted below.

Policy / Government-to-government (G2G)

Considering the policy ambitions and development on both sides, one could consider the following activities:

- Political dialogue aimed at sharing best practises on the use of digitalisation from prevention to care & cure;
- Exchange of expertise in developing and implementing policy instruments aimed at accelerating user-friendly digitalisation in health & care ;
- Bilateral visits of policy experts focused on ensuring the interoperability of health data infrastructure(s), certification of digitalised products and services, etc.

Ecosystems

The present report focuses on two regions in France, Ile-de-France and AURA, as they hold strong ecosystems in the field of digitalisation. We suggest to connect ecosystems on both sides in order to ensure sustained results with impact. One could think of the following activities:

- Organising a (public-private) workshop on how to increase the impact of e-health, based on a patient journey ;
- Exchange of expertise and best practises on how to stimulate regional scaling up of digital products and services in health & care ;
- Identify projects for cooperation within Horizon Europe and other European programmes.

Business-to-business (B2B)

Various companies are seeking for business partners in the value chain aimed at developing economies of scale, for instance. Valuable activities could therefore be:

- Connecting startups to investor incubators, business angels, investors;
- Participating in respective business fairs (innovation, trade, investment), for an overview of the annual LSH and digitalisation fairs in France, see appendix 5;
- Connecting companies to procurement departments / organisations.

Knowledge-to-knowledge (K2K)

Both France and the Netherlands are known for holding a very strong knowledge base in the field of life sciences & health and thus also in the field of digitalisation in health & care. Considering the current state of affairs in key enabling technologies, in particular Artificial Intelligence, ways of further strengthening bilateral K2K-cooperation could be:

- Co-authoring scientific articles;
- Set up scientific projects in the frame of Marie Curie and broader within Horizon Europe (including partnering with enterprises) ;
- Participating in respective scientific congresses as (keynote) speakers ;
- Taking part in public-private partnerships.

Public support

The Netherlands Entreprise Agency (RVO) and the Embassy can assist Dutch enterpreneurs and researchers in four ways:

1. Knowledge and information: besides drafting studies on different sectors (like the present report on digitalisation in health & care), RVO and the Embassy can inform entrepreneurs, researchers and public authorities about opportunities, trends, the local situation and more;

2. Network and contacts: via the network of the Embassy assistance can be provided aimed at finding the right contacts needed in order to move from an initial contact to concrete cooperation;
3. Representation of interests: throughout any process obstacles might be encountered. The Embassy can be of assistance to overcome obstacles in setting up partnerships;
4. Financing: the RVO has a huge range of financing tips, including EU programmes, and mechanisms matching ambitions of entrepreneurs and researchers aiming at setting up partnerships with French counterparts.

Conclusion

The world is changing and digitalisation is playing - and will continue to play – a key role in it. As this report clearly points out, we are witnessing a genuine turning point in health and care, as digitalisation is developing at an increasingly rapid pace. This paradigm shift calls for our health systems and health care to adapt accordingly. Indeed, societal challenges such as an ageing population and citizens affected by chronical diseases call for an increase in digital solutions.

At present, it is mainly doctors and specialists who are equipped and supported in decision making processes based on various technologies and software. In (the near) future, it will be patients themselves who will be supported in their decision making processes based on their own medical data. This development represents the very essence of personalised medicine and the new trend towards outcome based healthcare. Tailor-made health & care is set to become the new standard. Citizens may increasingly become empowered in all phases of their life cycle based on appropriate digital products and services in line with their own choices and needs.

As objects and services are becoming increasingly connected, e-health will also become increasingly an integral part of health & care. Whereas supply in e-health still exceeds demand, this might rapidly be reversed provided new digital products & services are citizen/patient-centred instead of technology driven only. That being said, all stakeholders, public and private, appear to agree on one major element: technology needs to work effectively in order to use e-health in a proper manner and connecting it to the health & care processes within and between health & care providers. Interoperability is key. In addition, e-health holds the potential of reducing workload among health care providers if framework conditions are properly met.

In this context it is worthwhile stressing that disruptive technologies such as artificial intelligence (AI) and blockchain are expected to play a crucial role in personalised medicine, as highlighted above. Indeed, AI allows for thousands of medical articles to be searched through in a very short time frame, whereas this same exercise would take months, or even longer, to human beings. This allows for doctors and specialists to focus on what they do best and on what they have been trained to do.

Moreover, further digitalisation in health & care clearly holds the potential of strengthening both the quality and the security of health & care, even save lives. Research, for example, shows that the number of death caused by mis-use of medication is three times superior to the number of death caused by traffic accidents. This is mainly due to a lack of appropriate information on what medication the patient was already taking, its allergies, etc.

Stepping up (investments in) R&D and innovation efforts is required to reap the full benefits of digitalisation in health & care. In view of the complexities characterising health & care, co-construction will increasingly become the trend in order to develop multitechnological solutions. Professionals will need to be trained accordingly, in an early stage and in increasing numbers in order to meet the increasing demand for digital health & care products and services.

France and the Netherlands share the same digital health & care challenges and are very much complementary in their respective ecosystems. As such, they appear to be natural partners in developing and implementing future-proof digital health & care products and services.

This report is hopefully another step in strengthening the bilateral relations in this promising field, also in a broader European context.

Appendices

Appendix 1 : Health Data Hub and the DMP

Data

Data is the sine qua non of e-health and research. The existence in France of a centralised health database should be a huge advantage to build tools to identify the best care, disseminate and adapt the care pathways of patients accordingly.

Health Data Hub

Because of the importance of data, the Health Data Hub is created. The hub will bring together all French data sources and aims to foster the development of AI projects in the field of health and therefore improve the quality of care by:

1. guiding the health system
2. improving the follow-up and the information of the patients
3. supporting the health personnel
4. finding out the needs of the healthcare providers.

This database will be accessible for both the patients and the health professionals. The patients remain the master of their own medical data and can chose to hide information or oppose a professional, except his healthcare provider which is in charge, to consult the files.
Data producers and users could be academic or private institutions, healthcare industries or startups and safety agencies. The strategy is to leverage existing initiatives and use local platforms to create this national data infrastructure. Examples are the databases of the public hospital group of the region Paris, AP-HP and the French Cancer Centre Federation. The health data which is financed by "la solidarite nationale" constitutes a common heritage and is at the service of all citizens and will get a legislative and governmental authority. The data of the Health Data Hub is hosted by a cloud provided by Microsoft.
The platform is being investigated with the first users from mid-2019. The first version of the platform is officially inaugurated December 2019 and in the same period the services and the first health data catalogue of the hub (consisting of 10 projects[clxxx]) were opened. The data will be made available for researchers, patient associations, institutions, startups and various stakeholders in the health sector. Before end-2020 the data catalog will be enriched and the first local hubs will be created. In total, five local hubs will be created that will implement the services, in for instance research on biology and health data. It is the aim that every French citizen will have an electronic patient record in 2022. [clxxxi]

Dossier Médical Partagé

The French initiative Dossier Médical Partagé (DMP) is a free secure digital health record that stores and secures the health information of citizens. The DMP The record includes hospital and radiological reports, results of bio-medical analysis, the history and allergies, important decisions that are made and the prescribed and used drugs. [clxxxii] The patient always has the possibility to close his or her DMP and can chose to hide information. The concept DMP is operational from 2011 onwards, and officially open for everyone from 6 November 2018. [clxxxiii] [clxxxiv] In the future the DMP will be linked to the Heath Data Hub. For this reason the two initiatives are working closely together. [clxxxv]

Appendix 2: National e-health programmes[clxxxvi]

National programme	Description
Télémédicine	Teleconsultations are authorised since September 15, 2018 and since all doctors should be able to propose a teleconsultations to its patients.
Programme Répertoire opérationnel des ressources (ROR)	The programme ROR aims to centralise the descriptions of various e-health offers of health establishments and the establishments/services in charge of elderly people with loss of autonomy and people with disabilities.
Programme Simphonie	Simphonie is a programme to simplify the patient's hospital journey and the digitalisation of the exchanged information.
Programme système d'information des Maisons départementales des personnes handicapés	The information system programme for departmental houses for the disabled is a tool to improve the quality of care and the coordination of the different interventions.
Système d'information des groupements hospitaliers de territoire	This programme focusses on the convergence of the information systems of the Groupement Hospitaliers de Territoire (GHT, Territorial Hospital Groups). The convergence will at the end result in the implementation of the same (e-health) services through the GHTs.
Systèmes d'information et de télécommunication des Samu-Centres 15	SI-SAMU is a programme to modernise the French emergency medical service
Système d'information des centres antipoison	The poison control centres are part of a CHU and mainly focus on consultations by phone and the toxic vigilance to assesses the risks of exposure to any natural, industrial or drug. The programme aims to modernise the information system of these centres (data security, data sharing on a national level and with other services)
Système d'information pour le suivi des victimes d'attentats et de situations sanitaires exceptionnelles	The information system for monitoring victims of attacks and exceptional health situations is an online portal that has been put in place after the attacks in Paris in November 2015. The portal makes it possible to inform and update information relating to (1) the identity of the patient, (2) the patient care and (3) the person to contact.
Portail de signalement des évènements sanitaires indésirables	The adverse health reporting portal gives patients, consumers, users and health professionals the opportunity to report an adverse health event or unusual effect with an impact on health (related to health products, everyday products or following an act of care).
E-parcours	E-parcours is a programme to improve the coordination between professionals in prevention, care and medico-social support and had among others a programme that applied to people aged 75+ from who the autonomy will deteriorate for medical or social reasons.
Sante.fr	The website Santé.fr and its mobile application provide information on health, pathologies and the offer of existing healthcare and services (e.g. via a geolocation service). One goal is to provide the website with functions to improve personalisation (for example by adapting the information provided to the living environment and interests of the users).
Echange de compte rendu d'examens de biologie médicale	The exchange of reports of medical biology examinations is regulated since 2016 and should always respect three criteria: structured in accordance with the interoperability framework for health information systems, inserted in the shared medical dossier (Dossier Medical Partagé) and communicated to the patient electronically using a secure electronic health messaging system.
Cahier des charges	The Cahier des Charges is a repository, validated by the French society of neonatology and the French speaking paediatric resuscitation and emergency group allows health institutions to draw up industrial tenders for the integration of these functionalities into the hospital information system.

Appendix 3: French pôles de compétitivité

Region	Pôle de compétitivité	Strategic lines
Île-de-France	Medicen Paris Region www.medicen.org	E-health, biological diagnosis, imaging, biotherapies, techno-therapy
Île-de-France	Cap Digital www.capdigital.com	Cluster for digital transformation also active on the health sector. [clxxxvii]
Île-de-France	Systematic Paris-Region www.systematic-paris-region.org	Technological cluster in among others data science, cyber and security, AI and IoT and one of the many themes is health. [clxxxviii]
AURA	Lyonbiopôle www.lyonbiopole.com	Medical technologies, medical devices and human and veterinary medicines
AURA	Minalogic www.minalogic.com	Cluster in digital technology with health as one of the application markets.
AURA	I-Care www.i-carecluster.org	A focus on specialised software information systems, computer-assisted surgery, electro-medical devices, medical textiles, implants, home care, serious game & devices for disabled persons. [clxxxix]
AURA	Medicalps www.medicalps.eu	Specialised in biotechnologies, medical technologies and e-health. [cxc]
AURA	Clara www.canceropole-clara.com	Supporting innovators in the field of mainly oncology. [cxci]
Region Saint-Etienne and Lyon	Pôles des Technologies Medicales www.pole-medical.com	Medical technologies (implants, prostheses, medical devices and health technologies)
Alsace	Alsace Biovalley www.biovalley-france.com	E-health, innovative medicines and therapies, medical technologies, diagnostics
Bretagne, Centre and Pays de la Loire	Atlanpôle Biotherapies www.atlanpolebiotherapies.com	Innovative technologies for biotherapies, immunotherapies, radiopharmaceuticals, regenerative medicine
North of France	Nutrition Santé Longévité www.pole-nsl.org	Cardiovascular, metabolic, neurodegenerative diseases, IBD, oncology, nutrition and health innovations, food security
Region of Toulouse	Cancer-Bio-Santé www.oncopole-toulouse.com	Within the themes cancer and aging: homecare, nutrition and health, molecules, technological and diagnostic innovations
South-east of France	EuroBioMed www.eurobiomed.org	e-health, (personalised) medicines, diagnosis, medical implants

Appendix 4: Health tech investors in Île-de-France and AURA

Investors Île-de-France	
Kurma Partners www.kurmapartners.com	Financing of innovation in healthcare and biotechnology (with a focus on rare diseases and diagnostics), from pre-seed to growth capital. Besides, Kurma manages healthcare investments of the Paris Saclay Seed fund, mainly on diagnostics and digital health. [cxcii] The Paris Saclay Seed fund is an investment fund led by students and alumni from the university Paris-Saclay [cxciii]
Partech www.partechpartners.com	Partech is a global venture capital firm and invests in internet and information technology startups at seed, venture and growth stages. Partech also manages healthcare investments of the Paris Saclay Seed fund, which is an investment fund led by students and alumni from the university Paris-Saclay. [cxciv]
Sofinnova Partners www.sofinnova.fr	An independent venture capital firm. Invest in startups, early-stage companies, corporate spin-offs and occasionally turnaround situations in the theme life sciences (Biopharmaceuticals, biotech, medical devices, industrial biotechnology).[cxcv]
LBO France www.lbofrance.com	Venture capital, LBO France offers a sectoral fund that is specialised in e-health. [cxcvi]
IDinvest www.idinvest.com	Idinvest Partners is experienced in financing high-growth companies in the healthcare sector and focusses on new medications, treatment processes and diagnoses in biotechnology, healthcare and nutrition. It has a partnership with Kurma Partners [cxcvii]
M Capital www.mcapitalpartners.fr	M Capital Partners is a private equity firm in the small-cap market. Health and digital are two of the five sectors in which M Capital invests. [cxcviii]
Caisse nationale de l'assurance maladie (CNAM) www.assurance-maladie.ameli.fr/qui-sommes-nous/organisation/cnam-tete-de-reseau/cnam-tete-reseau	The national fund for health insurance, CNAM, has an partnership with Bpifrance and identifies and financially supports French startups that are developing innovative solutions in the sector health. [cxcix]
BigBooster www.bigbooster.org	BigBooster is an acceleration programme for early stage startups (that have a proof of concept or a prototype). It is oriented to startups that have international ambition. One of their areas of activity is e-health. [cc]
Serena www.serena.vc	Serenaventures invests in early growth digital and tech startups, especially in AI and big data. [cci]
Omnes capital www.omnescapital.com	Omnes Capital is a venture capital firm with the two target sectors tech and health and focusses on the themes digital (advanced software), deep-tech (big data) and life sciences (biotech, medtech and diagnostics). [ccii]
Innovation Capital www.innovationcapital.fr	Innovation Capital is an international venture capital firm that invests in information technology and healthcare services and has a sector fund that supports the silver economy. The firm invests in both early and later stage companies. [cciii]
Seventure partners www.seventure.fr	The venture capital, Seventure Partners funds accompanies startups in two fields: digital technologies and life sciences. [cciv]

Investors Auvergne-Rhône-Alpes	
MM Innov'	MM Innov' is an investment funds that is part of the large Malakoff Médéric company. MM Innov' is created with the aim to support startups in the fields of health, e-health and fintech with its financial resources. Malakoff wants to collaborate with startups in: (1) Health, (2) Human ressources (3) Insurance and (4) social and societal engagement (disability, job retention, caregivers, cancer)[ccv, ccvi]
Kreaxi www.kreaxi.com	Kreaxi is an investment company that supports innovative and technological startups in a financial way. Kreaxi has been supporting regional startups for over 30 years. [ccvii]
Angelor www.angelor.biz	Angelor is a company active on the investment market. Angelor invests in promising projects of startups and connects these startups with other (private) investors. One of the focusdomains of Angelor are innovative companies in the health sector. [ccviii, ccix]
Business Angels Auvergne-Rhône-Alpes www.business-angels-auvergne-rhone-alpes.fr	Business Angels Auvergne-Rhône-Alpes is a group of investors active in the region AURA. As part of the national alliance called French Angels, this group stimulates the growth of ambitious entrepreneurs by investing capital. [ccx]
Hi Innov www.hiinov.com	HI Innov provides financial aid to innovative startups and SMEs especially in the digital sector. For example, Hi Innov invests in projects that can offer IoT solutions. [ccxi]
SEB Alliance www.groupeseb.com	SEB Alliance is an investment department of the Groupe Société d'Emboutissage de Bourgogne (Groupe SEB), a French constortium that produces small appliances. SEB Alliance invests in the fields wellbeing (e.g. ageing), worldwide connection (IoT, Robotics & digital service applications) and sustainable development. [ccxii]
Expansinvest www.expansinvest.fr	Expansinvest is an investment association that is part of Banque Populaire Auvergne-Rhône-Alpes and supports SMEs. [ccxiii]
Siparex www.siparex.com	Siparex is an independent capital investment group headquartered in Lyon. Siparex invests in startups and SMEs by doing capital development, becoming majority or minority shareholder and facing capital risks. [ccxiv]

Appendix 5 : Non exhaustive annual LSH & digitalisation fairs in France

Annual events	Date & Location	Participants	Theme
AgeingFit www.ageingfit-event.com	Jan/Feb Nice	600	Healthy ageing
NutrEvent www.nutrevent.com	Oct Alternates between Lille, Rennes, Nantes	600	Nutrition and health
BioFIT www.biofit-event.com	Dec Marseille	1300	Life sciences
SantExpo	May Paris	30000	All the health players
Hacking Health Camp www.hackinghealth.camp	March Strasbourg	500	Future of health
MedFIT www.medfit-event.com	June/July Grenoble/ Lille/ Strasbourg	700	Medical technologies, diagnostics and digital health
Hacking Health Lyon www.hhlyon.org	Nov/Dec Lyon	N/A	Front-line healthcare problems
I4ID www.i4id.org	Dec Lyon	N/A	Immunotherapy, microbiota, new antimicrobials, diagnostic tools, biomarkers, epidemiology, NGS strategies, real-time follow up and the use of AI in these fields.
Tech Days Santé www.healthtechdays.com	April Lyon	N/A	Data and AI in the health sector

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Glossary of terms

AI	Artificial Intelligence
AURA	Region Auvergne-Rhône-Alpes
CHU	University hospital (Centre hospitalier universitaire)
DMP	Dossier Médical Personnel
DNS	Digital health delegation (Délégation ministérielle du numérique en santé)
DL	Deep learning
GHT	Territorial Hospital Groups (Groupement hospitaliers de territoire)
HAS	French National Authority for Health (Haute Autorité de Santé)
HDS	Health data hosting (Hébergeurs de Données de Santé)
IHU	University hospital institutes (instituts hospitalo-universitaires)
IoT	Internet of Things
LSH	Life Science and Health
NBSO	Netherlands business support office
PD	Pharmaceutical Dossier
R&D	Research and development
SME	Small-to-medium enterprise

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