ManagiDiTH
ADVANCED DIGITAL SKILLS

SKILLS NEEDS FORECASTING ON DIGITAL HEALTH ECOSYSTEMS

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Skills Needs Forecasting on Digital Health Ecosystems

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Note on the ManagiDiTH consortium
The ManagiDiTH project consortium is funded by the EC Digital Europe Programme (EC-HADEA Grant Agreement No. 101083896) and runs from 2023-2027. University members of the consortium are ISCTE - Instituto Universitário de Lisboa, Aristotel University of Thessaloniki (AUTH), Laurea University of Applied Sciences, ESIEE Paris / Université Gustave Eiffel (UGE).

Keywords Digital health, technology, skills demand, education, Europe

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Executive Summary

Introduction

The need to adapt to rapid technological change and take advantage of digitalisation of services led to the setting up of the Managing Digital Transformation in the Health Sector (ManagiDiTH) project which has been formed and funded to develop a Master's programme to facilitate specialised digital skills for the health sector. The Master's programme is being co-created through an intercultural collaboration of lecturers and sector experts. To ensure that the programme is designed to meet the current and anticipated needs in the digital healthcare sector, a Skills Need Forecasting exercise was conducted in the four countries of the ManagiDiTH consortium (Portugal, Finland, France and Greece) in the spring of 2023.

Study objectives

The objective of the skills need forecasting study was to consolidate the assessment of social, economic and technological trends in the health sector and their impact in terms of organisational and individual capacities. Specifically:

a) What are the main social, economic and technological trends in the health sector, and their impact in terms of organisational and individual capacities?
b) What are the key health sector trends and qualifications and skills needs which should be included in order to promote future relevance of the training programme?
c) How should the ecosystem of future digital skills needs be considered?

Methods

This research consisted of three activities. Data collection – desk review, focus groups and individual interviews – was conducted in all four countries between February and May 2023. In each participating country:

1. We carried out a Desk Review of the main and most recent developments in these fields.
2. We conducted a series of focus groups with experts from the digital and health sectors, and with service users, and members of stakeholder and patient associations.
3. We conducted a series of individual interviews with key experts/stakeholders in the field.

A total of 60 people took part in 15 focus groups in the 4 countries, and a further 19 took part in individual interviews. Participants were asked questions about the following areas:

1. Digital healthcare: issues, competencies, needs trends.
2. Expectations of and suggestions for Master's programme design
3. Mapping the digital health ecosystem.

Findings

The skills need study identified key trends, challenges, and opportunities for the digital health sector. Major demographic changes across Europe are placing strong pressures on health services, but other trends, and digital innovation, are bringing new possibilities and solutions to the problems.

Key trends in healthcare provision and possibilities for digital transformation include:

- Trend towards dual systems of healthcare and a mix of public and private providers
- Increased technological capacity and acceptance of telemedicine
- Digital health self-management
- Staff shortages, burnout and skills gaps possibly mitigated by suitable digital solutions

Key gaps and challenges for the transformation of digital health include

- Digital accessibility and equality
- Sustainability of technological solutions
- Budget constraints
- The centrality of the patient voice and experience
- The need for interoperability across national borders
- Data security concerns

Conclusions: developing the ecosystem for digital health

The concept of the ecosystem is at the centre of the aims and values of the ManagiDiTH Master's programme. This digital ecosystem is also relevant to developing a broad and inclusive understanding of how to manage the digital transformation of the health sector. The need to move out of disciplinary and professional silos, into a more multidisciplinary understanding, will be essential for future professionals in the relevant digital and health sectors. This skills need study has highlighted the centrality of integrated systems within healthcare and digital services, but also across different types of health and social care, and across national borders.

Recommendations

Recommendations are made for education and training, for equality and accessibility of digital healthcare solutions, for digital changes within the wider ecosystem, and for development of digital solutions,

Key recommendations include:

- There is an urgent and growing need for professionals who are trained in both healthcare and in digital skills
- New training programmes are needed to enable interdisciplinary knowledge, skills and competencies.
- Patient groups and service users should be involved at all stages of development of services, programmes and technology.
- Training programmes should work with international competency frameworks (we especially recommend IMIA, 2023) so that graduates have internationally acceptable qualifications.
- Technology developers and social partners need to collaborate to ensure everyone in society has the skills to use everyday technology.
- Specific work needs to be done with minority communities, and with vulnerable groups (for example older adults) to ensure materials, technology and communications are acceptable, understood and appropriate.
- When developing digital services, the change in the entire service process must be taken into account.
- Data security issues cross technology, ethics and national/international regulations
- Interoperability needs to be developed internationally, in line with EU regulations rather than national expectations.

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Glossary of Key Terms

ADS	Advanced Digital Skills
AI	Artificial Intelligence
BI	Business Intelligence
EC	European Commission
EQF	European Qualifications Framework
EU	European Union
GDPR	General Data Protection Regulation
HCP	Health Care Professional
ICT	Information and Communication Technologies
IoT	Internet of Things
IT	Information Technologies
ML	Machine Learning
NHS	National Health Service
OECD	Organisation for Economic Cooperation and Development
RWD	Real World Data
WHO	World Health Organisation
WP	Work Package
5G	Fifth Generation

1. Introduction

Among the European Union's (EU) targets by 2030 is the aim of a human-centric, sustainable vision for digital society to empower citizens and businesses. The main goals are to develop a digitally skilled population and highly skilled digital professionals, secure and sustainable digital infrastructures, the digital transformation of businesses and the digitalisation of public services (European Commission, Europe's Digital Decade: digital targets for 2030, 2022). The need to adapt to rapid technological change and take advantage of digitalisation of services led to the setting up of the Managing Digital Transformation in the Health Sector (ManagiDiTH) project which has been formed and funded to develop a Master's programme to facilitate specialised digital skills for the health sector. The ManagiDiTH project consortium is funded by the EC Digital Europe Programme (EC-HADEA Grant Agreement No. 101083896) and runs from 2023-2027. University members of the consortium are ISCTE - Instituto Universitário de Lisboa, Aristotel University of Thessaloniki (AUTH), Laurea University of Applied Sciences, ESIEE Paris / Université Gustave Eiffel (UGE). The Master's programme is being co-created through an intercultural collaboration of lecturers and sector experts. To ensure that the programme is designed to meet the current and anticipated needs in the digital healthcare sector, a Skills Need Forecasting exercise was conducted in the four countries in the spring of 2023.

As noted in recent reports, the shift to digital transformation across many sectors of the economy has become increasingly important (LEADS, 2023), and with this, the skills gap between the existing workforce and anticipated need is an urgent concern. The shift to digital transformation in the health sector has specific challenges, not just rapidly changing technological challenges e.g. of Artificial Intelligence (AI), interoperability, cybersecurity, but also the ethical and social implications of technology in the health sector, including data protection and GDPR regulations, but also challenges of digital accessibility for the most vulnerable citizens, who are often the very groups most likely to need healthcare.

The gap in expertise between healthcare professionals and IT experts in both content of training programmes, and in skills used daily in the job, has been immense, but with the digital transformation of the health sector there is an urgent need for new and flexible combinations of skills and training, both for development and monitoring of suitable technologies, but also for use of health related technology by both healthcare professionals and by patients and service users - which in practice means all citizens (Ahonen et al. 2023).

The aim of this report is to provide insights and recommendations, based on the first activity of the four-year project, a Skills Need Forecasting task- to consolidate the assessment of social, economic, and technological trends in the health sector and their impact in terms of

organisational and individual capacities. Other recent skills needs assessments are included and built on, including the Advanced Digital Skills (ADS) Demand and Forecast report (LEADS, 2023), and recent assessments of health needs in the EU (OECD/European Union, 2022). However, the ManagiDiTH programme is unique in its focus on assessing trends and needs in digital health in Europe, with a view to informing training and education in this crucial and rapidly expanding field.

1.1. Objective of Skills Need Forecasting study

The objective of the skills need forecasting study was to consolidate the assessment of social, economic and technological trends in the health sector and their impact in terms of organisational and individual capacities. The study aimed to get state of the moment feedback on a wide variety of stakeholders and experts' views on the content, design and structure of the Master training program, which we consider in terms of the Europass EQF level 7 categories (https://europa.eu/europass/en/description-eight-eqf-levels) of knowledge, skills and autonomy and responsibility (termed in this report as "experiences") expected to be acquired by the students.

Specifically:

a) What are the main social, economic and technological trends in the health sector, and their impact in terms of organisational and individual capacities?
b) What are the key health sector trends and qualifications and skills needs which should be included in order to promote future relevance of the training programme?
c) How should the ecosystem of future digital skills needs be considered?

This research consisted of three methodological activities. In each participating country:

1. We carried out a Desk Review of the main and most recent developments in these fields.
2. We conducted a series of focus groups with experts from the digital and health sectors, and with service users, and members of stakeholder and patient associations.
3. We conducted a series of individual interviews with key experts/stakeholders in the field.

The results from these three activities have been combined in this report. Initial findings were presented to participants, and to international panels of teachers and sector experts, who provided feedback on the analysis which was revised accordingly.

2. Methodology

Data collection – desk review, focus groups and individual interviews – was conducted in all four countries between February and May 2023.

2.1. Desk Review

The desk review was structured by a template for each country to follow. Partners were asked to focus strategically on the main social, economic and health trends in their country. They were asked to identify particular strengths in digital health in their country, and also the main gaps and needs and challenges anticipated for the sector. The results of this review are integrated into this report.

2.2. Focus groups and Individual Interviews

2.2.1. Sample and participation

A total of 60 people took part in 15 focus groups in the 4 countries, and a further 19 took part in individual interviews.

	Number of FGs	Total FG participants	Total individual interviewees	Total participants in country
Portugal	3	14	5	19
Greece	2	6	4	10
Finland	7	23	5	28
France	3	17	5	22
Total	15	60	19	79

Table 1. Participants in Focus Groups and Interviews

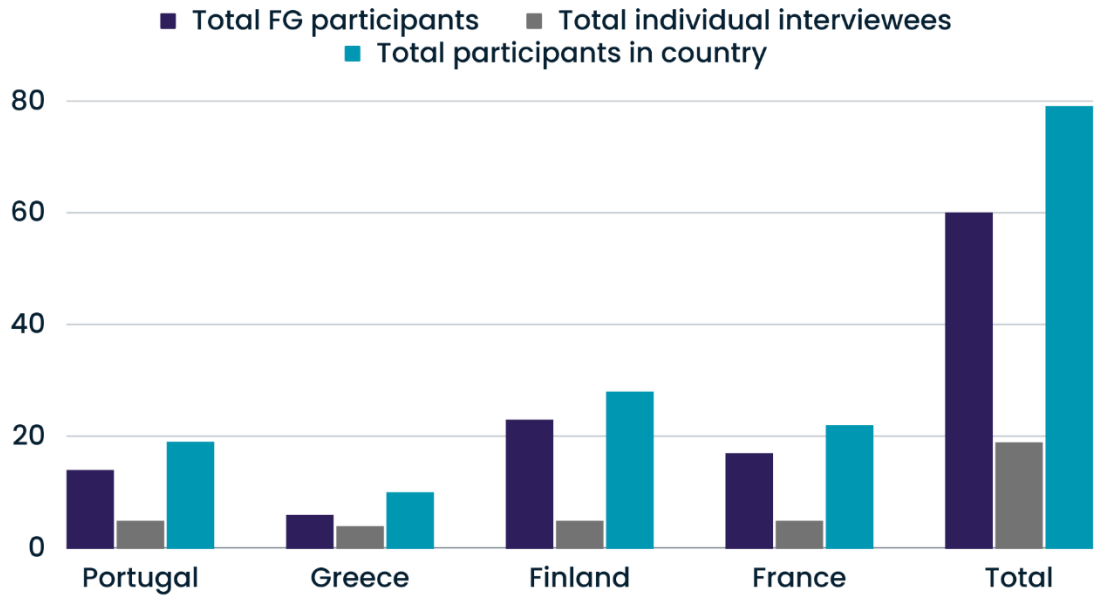

Figure 1.

Figure 1. Participants in Focus Groups and Interviews

Portugal

In Portugal, three focus groups took place. One with IT sector professionals, one with health sector professionals, and one with patient associations, regulatory bodies and other stakeholders. Five individual interviews were conducted with: former Director-General Ministry of Health responsible for digital transformation in Portugal, a leader of hospital Training, pharmacist/ representative of a patients' association, and an expert responsible for the training area in the ACCS - Ministry of Health

Finland

Interviews were conducted with professionals from IT companies, health and social care, health and social care ICT units, higher education, ministry of social and health care, Finnish Institute for Health and Welfare and patients' associations.

France

Three focus groups were conducted with health professionals, health IT companies, health ministry, researchers in e-health and patients, all of them with different background and knowledge in e-health. Five interviews were also conducted with health professionals and/or health IT companies CEOs, with a good experience in e-health.

Greece

In Greece, two focus groups took place. The first focus group consisted of three in-person participants with experience in the field of digital physics. The second focus group was also conducted in person and included individuals from the Health Region Administration of Macedonia. Four individual interviews took place, with a medical doctor, a representative from patient association representative, an IT professional from the Health Region Administration and a professor of digital medicine.

2.2.2. Focus groups: methods and procedure

Participants were asked to attend one focus group, lasting 60-90 minutes, on Teams. In practice some focus groups lasted up to two hours, and it was noted that more time could have been taken to discuss these issues. They were given information about the project before the group, in a participant information sheet which included two diagrams showing the proposed Master's programme design, and the concept of the ecosystem. They also received a consent form (study documents can be viewed in Appendix 1).

Focus group participants were asked questions about the following areas:

1. Digital healthcare: issues, competencies, needs trends.
2. Expectations of and suggestions for Master's programme design
3. Ecosystem mapping.

Focus group and interview participants were shown a diagram of the proposed Master's programme structure (see Appendix 1), and they were asked for opinions about what they consider the core, essential skills and competencies for students to cover in the Digital Health Master's programme.

2.2.3. Interviews: methods and procedure

The procedure for individual interviews was similar. Participants were provided with an information sheet and a consent form in advance. Interviews lasted 30-60 minutes and were recorded, with participants' consent. It was specified that consensual recordings would only be used for the project development. As with the focus group data, any comments or information shared were fully anonymised. Any recordings and any transcription or notes taken, will be deleted at the end of the four year project. Data storage follows GDPR regulations. For some interviews, recording did not take place, but notes were taken instead.

Interview participants were asked about the following areas:

1. Main challenges facing the health sector.

2. Current gaps in skills, knowledge and experience.
3. Key competencies needed
4. Expectations of and suggestions for Master's programme design.
5. Ideas for engagement with stakeholders throughout the project

2.2.4. Ethical considerations, confidentiality and data management

For the focus groups and the individual interviews, participants were provided with information sheets and consent forms by email before the event. At the start of the focus group, participants were asked for their consent to take part, and for sessions to be audio- and video-recorded. If everyone gave consent, the focus groups were recorded on MS Teams. The recordings were used to develop themes from the groups and will only be used for the project development. All comments and information shared has been anonymised. For individual interviews, recording took place if interviewees wanted this. Otherwise, notes were taken.

All recordings, together with any transcription or notes taken, will be deleted at the end of the project. Data storage follows GDPR regulations. Where required, ethical procedures in the different institutions were followed to obtain ethical approval for this activity (see appendix X). See Appendix for participant information sheet, consent form, focus group and individual interview schedule.

3. Results: Social, economic and technological trends in the digital health sector

3.1. Health Care Systems in the four countries

It is hard to make comprehensive international comparisons about health care systems. In life expectancy, all four countries have high levels of over 80 years of life expectancy for both men and women (Eurostat, 2023b). The WHO uses a single measure, the Service Coverage Indicator (SCI), to track the extent to which people are able to use the health services they need (WHO, 2022). According to this measure, Portugal comes out highest of the four countries in this study. In measures of healthcare spending per citizen, both overall, and related to GDP, Finland scores highest. Below is a summary of some key features of the health care system in each of the partner countries.

	Summary of system (Source: Euro health observatory, 2023)	Key aspects of system and recent changes noted in national desk review
Finland	Finland has a decentralized, tax-based health funding system, with about 300 municipalities responsible for the organization and provision of services to citizens and permanent residents. The municipal health care services cover all necessary health services at all care levels and are accessible to residents of the respective municipalities. Certain population groups, including asylum seekers without a residence permit, undocumented immigrants and foreign temporary workers, are not covered, but do have access to essential emergency care.	After the Second World War, Finland developed towards a Nordic Model welfare state, with relatively low levels of inequality, and with welfare services and health care provided by a strong public sector (Nordic Co-Operation 2023). This has enabled a form of individualism, where safety nets provided by a strong state enable independence from family and other social groups. At the start of 2023, Finland had a major health care reform, where the responsibility for care was transferred from 300 municipalities to 21 wellbeing counties. The aim of this reform is to give more person-centred care to citizens, and to organise health and social services more coherently. The strategy is also that, if possible, the first contact should always be via digital services. Health and Social Service Reform https://soteuudistus.fi/en/frontpage
France	France runs a statutory health insurance (SHI) system providing	Despite several organizational changes that have devolved power to regional

	universal coverage for its residents. The system is financed through employee and employer contributions, and increasingly by earmarked taxes on a broad range of revenues. The main schemes that provide SHI are one specific to the agricultural sector and another more general scheme, with the same coverage and benefit policies. Funds are pooled at the national level with the possibility of subsidies between schemes. Voluntary, complementary private health insurance (VHI) also plays a large role. Almost 95% of the population has VHI with means-tested subsidies for 10.5% of the population and 8% of lower-income individuals fully subsidized.	health agencies, the central government has retained substantial control over the governance of the health system. Recently, France has moved in a new direction towards prevention, health promotion and patient empowerment, which breaks from the previous more paternalistic system that focused on curative care. In the public sector, an investment plan of 19 billion euros over 10 years, including 7.5 billion euros to finance projects to transform the sector. The rise in per capita medical costs recently returned to pre-pandemic levels. Emmanuel Macron recently presented his Health 2030 innovation plan for the short, medium and long term evolution of the healthcare system.
Greece	Greece offers universal coverage for health care. In 2016, additional funding was allocated to cover previously uninsured groups of residents and registered migrants for services provided by the National Health System. The National Organisation for the Provision of Health Services (EOPYY) was established in 2011 to manage a single unified health insurance fund and to act as the sole purchaser for publicly funded health services delivered by the National Health System.	Although Greece's National Health System provides universal health coverage, a considerable portion of healthcare expenses is covered through a social insurance model. Contributions are made through payroll taxes, and private spending makes up the remaining 40 per cent (Apostolopoulos et al., 2022). Investigations conducted in this sector indicate that 90% of these expenses are borne directly by individuals, with only 10% being covered by private insurance companies (HCC, 2021).
Portugal	Portugal's National Health Service (NHS) is a universal health system covering all residents, regardless of their socioeconomic, employment or legal status. The Ministry of Health concentrates most planning and regulation centrally, while the five	Portugal has a dual model of healthcare: free public provision, supplemented by private providers who duplicate and supplement the NHS (Tavares & Marques, 2020). In 2015, 16% of the population had double coverage (NHS plus private insurance, mostly provided by employer schemes. There is a digital

	regional health administrations manage the NHS at the local level.	gap between private and public health institutions, as the private usually have a wider availability of solutions and digital offerings to its patients (Mendonca, 2022).

Table 2.Summary of national health care systems

Many trends in these countries are common to many European and other highly developed countries. These shifts include a changing demographic, migration, and the social effects of new technological developments.

3.2. Social and Demographic trends

3.2.1. Ageing population

All four countries have notably ageing and declining population in recent decades, with low birth rates and increased life expectancy (OECD, 2022). France and Finland are both in the top 3 EU countries for life expectancy. Life expectancy declined slightly due to the covid-19 pandemic, but in general is rising in all European countries. This demographic change puts pressure on each country's health sector in terms of sustainability, efficiency, costs management, high demands, and changing digital needs.

3.2.2. Migration and impact on health sector

Of the four countries in this study, only Greece has recently had high levels of immigration compared to EU average (Eurostat, 2022c), but each country has had impact of immigration in the health sectors. Greece has high migration particularly from Middle Eastern and African countries, including many forced migrants and asylum seekers, which has led to challenges in the health sector due to extra demand, language barriers and cultural differences. Portugal has high rates of emigration, especially of younger adults, which is exacerbating skills shortages in the labour market, and Portugal meanwhile has various immigrant populations with specific conditions and health needs, for example tuberculosis and monkeypox. These tend to be concentrated in the immigrant populations in urban areas (Perreira et al, 2019; Duque et al, 2022). Finland has relatively low levels of immigrants in comparison with other OECD countries (VATT 2014), and immigration also balances the shifting age structure, as people immigrating to Finland are on average younger than the Finnish population (valtioneuvosto.fi 2021) - this is the case for immigration in general into EU countries.

3.2.3. Increasing education and qualification levels

Younger Europeans have increasing educational and qualification levels, high literacy rates and high proportions of young adults with tertiary education. In the past two decades, the share of young adults with advanced qualifications has risen sharply across OECD countries: 48% of 24-34 year-olds had a tertiary degree in 2021, compared to just 27% in 2000 (OECD, 2022).

Educational attainment is becoming an increasingly important factor, both in the labour market and for individuals. Across Europe, in society in general, and in the labour market, education is increasingly valued. In the coming years it is expected that there will be an increased demand for highly skilled people with the relevant education in order to manage jobs that are more flexible and complex. More generally, having at least an upper secondary education is often considered as the minimum level that helps individuals to be equipped for a full participation in society and to live a fulfilling life (Eurostat, 2022a). Young women have higher educational levels than men. On average across OECD countries, the share of younger women (25-34 year-olds) with tertiary education is 53% compared with 41% for men (OECD, 2022). While there are still national differences in levels of education and qualification, the generational shift to higher levels of education and qualification is similar across the continent. In all countries, there are persistent skills shortages in the health and ICT sectors (OECD, 2022).

3.3. Main health trends in the four countries

A combination of demographic and social change, plus the global Covid-19 pandemic, are leading to severe challenges in healthcare systems internationally notably:

3.3.1. Impact of Covid-19 on healthcare sector

The COVID-19 pandemic has had a significant impact on the healthcare sector worldwide, including in Europe (OECD/European Union, 2022), with the result that people with chronic illnesses are turning away from care and delaying screening – exacerbating the increase in chronic diseases already occurring due to increasing levels of obesity and sedentary lifestyles (Pereira et al, 2021). In Greece, the public health systems were particularly challenged and revealed significant limitations in capacity, resources, and functions (Karokis-Mavrikos et al., 2022). The COVID-19 pandemic has had a significant impact on the Greek health sector, with a high number of cases and deaths, leading to increased pressure on healthcare services and an average of 8.1% of the national GDP spent on healthcare (OECD, 2021).

3.3.2. Teleconsultations and telemedicine

Expectations and capacity of healthcare professionals and patients to utilise virtual settings for meetings and consultations has led to widespread changes in healthcare practice. For example, during the Covid-19 pandemic, three-quarters of French GPs implemented teleconsultations (compared with less than 5% previously). 9.4 million teleconsultations in 2021, compared with 80,000 in 2019. Remote consultations account for 4.8% of the activity of self-employed GPs under 40, compared with 2.5% of that of their colleagues aged 65 or over. 45.2% of teleconsultations involve patients aged between 15 and 44 (compared with 28.7% of in-office consultations). 70% of teleconsultations are carried out with patients living in urban areas, with most teleconsultations taking place close to the patient's place of residence.

3.3.3. Increasing levels of chronic and long-term health problems

All four countries have increasing levels of chronic or long-term health problems (OECD/European Union, 2022). Diabetes tops the list of chronic diseases, but the list also includes cardiovascular disease, and cancer. 10 million people in France suffer from one of the thirty diseases classified as chronic, with 2.6 million people affected by diabetes, and 2 million with malignant tumours. Heart-related pathologies (heart failure, rhythm disorders, heart disease) affect 1.1 million people, while long-term psychiatric conditions, excluding Alzheimer's-type dementia, are on the rise, affecting 1.3 million people. In Greece, similarly, there is an increase in chronic diseases such as diabetes, cardiovascular disease, and cancer; as main causes of death, the OECD lists ischaemic heart disease, stroke, and lung cancer (OECD, 2021). The Finnish Institute for Health and Welfare (2023) emphasizes that mostly because people live longer the leading public health issues are infectious diseases, chronic diseases (e.g., cardiovascular diseases, diabetes, asthma and allergies, chronic respiratory diseases, musculoskeletal diseases) and accidents. Various memory disorders, mental disorders, and cancer are also in a significant role.

3.3.4. Multimorbidity

Multimorbidity – having two or more health conditions - is another, related feature of ageing populations. The Survey on Health, Ageing and Retirement in Europe (2020) found that 36% of people aged 65 and over reported having at least two chronic diseases on average (reported on OECD, 2022). For example, in France, disability-free life expectancy at age 65 is also slowing down but growing faster than life expectancy at age 65. The aging of the population is leading to an increase in dependency. The number of dependent people in mainland France is expected to multiply by 1.4 between 2010 and 2030 (from 1,150,000 to 1,550,000) and by 2 between 2010 and 2060 (from 1,150,000 to 2,300,000). This raises the question of the number of places

available in nursing homes, and their capacity to absorb this demographically-driven increase in patient numbers. This increase in multimorbidity, especially in rural areas (Santiago et al, 2020) is also noted in Portugal, which is experiencing challenges of end-of-life care (Gomes et al, 2020).

3.3.5. Increasing levels of mental health problems

Reported levels of mental health problems have been rising internationally in recent years. This is partly due to raised awareness and acceptance of mental illness. However, during and since the Covid-19 pandemic, rates of mental health problems have soared, with young people and children particularly affected. There is a noted lack of mental health resources in Portugal, despite high prevalence of mental health problems in the population. Mental health in Greece has become a growing concern, with a large proportion of adults (15% compared with 11% in the EU) reporting symptoms of psychological distress (OECD, 2021). In France, "depression, chronic anxiety, bipolarity, phobias, suicidal thoughts... psychological disorders now affect one in four French people". About 50% of young Europeans reported unmet needs for mental health care in spring 2021 and again in spring 2022 (OECD 2022). The consequences of such disorders are major for the individuals concerned, who present an increased risk of suicide, and more generally a higher risk of premature mortality. Actions are being taken to counter the increase in these disorders: dashboards of the main indicators and censuses of at-risk populations, remote assistance systems, and the introduction of prevention and mental health promotion measures.

3.3.6. Health management trends

A trend noted across Europe is the trend to a mix of public and private healthcare systems, with increased links between the two, and problems that this may cause. Financial pressures on public (free to access) healthcare systems have led to more integration of systems, but often leading to integration problems, and also widening inequalities in access to healthcare. For example, in Portugal, the dual model of healthcare between public and private providers is poorly implemented, though an increasing number of people are accessing private healthcare as well as public.

3.3.7. Staffing pressures and burnout: retention and recruitment problems

In many countries, there are high levels of healthcare staff burnout and depression due to covid-19 pandemic (Serrão et al, 2021). This has exacerbated pre-existing pressures on staff due to higher demand and limited staff. For example, in France, 45% of General Practitioner doctors reported suffering from burnout, one in four doctors is over 60 years old and soon to retire, and

training of new doctors is unlikely to catch up with demand. In Portugal, reorganisation of the national health service led to reduced salaries, meaning lower wages for healthcare professionals than elsewhere in the EU, which led to many healthcare professionals emigrating. A sustainable workforce is therefore a challenge (Simões et al, 2017). Even in Finland, which has a high level of healthcare spending compared to other OECD countries, pressure to cut costs has made working conditions for healthcare workers such as nurses more demanding. Combined with lower earnings than the average wage of all workers, it is becoming more difficult to attract new workers to the healthcare sector.

3.4. Major economic trends in the health sector

3.4.1. Higher levels of economic spending in health and care

A common factor is increased spending in health and care sectors, and expectations of further spending needed to cope with both technological change and the demographic challenges of older populations. In Europe, in 2020, an unprecedented 10.9% of the GDP of the EU was devoted to healthcare, but even before the covid-19 pandemic the proportion of GDP spent on healthcare was increasing (OECD, 2022). Greece is the outlier here, with economic pressures resulting in the healthcare budget having been reduced in recent years, leading to a general dissatisfaction and added concerns about the quality of care and access to healthcare for vulnerable groups (Petmesidou, 2019). This is resulting in changing expectations of public healthcare systems, and there is a rise of private health systems and insurance in each country. For example, even though universal health care is in place in Finland, there has been a growing interest in private health insurances. The demand has developed hand in hand with a concern of availability and quality public health services organized by municipalities. In 2017 there were nearly one million health insurances acquired. The amount grew 35 % in 8 years. In particular, Finnish households with children take up health insurances for their children, but for the guardians at the same occasion. Households that consist of retired citizens are much less interested in health insurances, only 6 % possess one. This may be due to a habit of relying on public health services, the cost and content may not fit their purposes or simply not paying attention to the matter after years of using private occupational health services covered by their employers. (Kajantie 2019.)

Private healthcare providers have been growing in Greece and centralization is evident especially in secondary care sector: eight large private clinics, seven of which are situated in Attica, account for 66% of the overall turnover, while two groups hold a 50% share of the total market; the particular companies hold great significance, as they are the largest in the health sector and their role in providing healthcare services to the population needs to be examined (Roupas & Charamis, 2022). In France, according to *Invest in France*, the healthcare industry

represents sales of €90 billion, 35% of which comes from exports. From start-ups to multinationals, nearly 3,100 life sciences companies generate some 455,000 jobs. In the private sector, several French start-ups in the healthcare sector are valued at over $1 billion. There are currently more than 2,600 healthtech companies in France. With 800 million euros in foreign investment and 1.16 billion in fundraising by 2022. Emmanuel Macron recently presented his Health 2030 innovation plan for the short-, medium- and long-term evolution of the healthcare system. The French President announced the creation of 12 new university hospital institutes (IHU). They will complement the seven existing IHUs. Ten of these IHUs will receive public funding ranging from 20 to 40 million euros. The other two (emerging IHU) will be financed to the tune of 5 million euros, to which a further 5 million may be added.

3.4.2. Medical demography and need for training health care professionals

A major economic pressure is the training and funding to address current and anticipated shortages of health care professionals. For example, the number of doctors in France is set to stagnate until 2030, before rising sharply until 2050. In Finland there is a growing concern of sufficient supply of health service workers which the government is targeting with several programs. For instance, a strategic roadmap for years 2022-2027 has been produced and it includes over 40 concrete action recommendations for years 2022-2023. The measures in the roadmap include e.g. ensuring a sufficient intake of students in education and training programmes as well as ethical international recruitment, developing the content of education and training, and making diverse use of technological solutions. (STM 2023)

3.4.3. Growth of personal health technologies

Patients and citizens are increasingly seen as active parties, engaged in the management of their own well-being (Giesler & Veresiu, 2014; Tikkanen, Heinonen & Ravald, 2023). For example, in 2020, 60 percent of the Finnish population had used the internet to search for health-related information (Kyytsönen, Aalto & Vehko 2021). This trend can partly be attributed to the rise of personal health technologies, but also to an increasing individualization in society. For the health sector, this trend is manifested in two ways. First, the patient is increasingly engaging with technologies and co-producing the health care service, together with professionals. Second, inhabitants can also engage more actively in preventative health, outside health care services. This is enabled by the growing market of health and wellness technologies, such as activity trackers and other wearables (Tikkanen, Heinonen & Ravald 2023). The democratization of what has been termed the IOT (internet of things) is also evident in the French healthcare sector, this development is part of a process of evolution in medical technologies, with the aim of

responding to short-, medium- and long-term issues. The most widespread current uses are remote patient monitoring using IoT devices, whereby patients without a physical presence in a healthcare facility can automatically collect health measurements, eliminating the need to travel and collect data themselves. These include blood glucose and heart rate monitoring, as well as depression and mood monitoring. This technological development is part of a more global policy to meet present and future challenges.

The growth in private-sector market offerings within health and well-being has led to customer-patients acting as coordinators of their own health ecosystems (Mickelsson et al. 2022) (to be explored further in the Ecosystem section).

3.5. Country differences

While many demographic, social and health trends are common across the four European countries, there are also variations, and there are notable economic distinctions. Some relevant national differences include:

3.5.1. High levels of health inequality in some countries

In general, health inequalities mirror social inequalities (Scholz, 2020; Arnault et al, 2021). Health inequality is relatively high in Portugal and Greece compared to the EU-27 average, and France also has high levels of health inequality. This is partly due to demographic/geographic variation – older population in rural interior, younger economically active population in major cities and coastal regions. High health inequality is also partly attributable to the binary nature of Portuguese health service, 20-25% of the population has access to a second layer of healthcare via private health insurance (Simoes et al, 2017). In Greece, the economic crisis led to high levels of unemployment, which has increased the financial insecurity, and overall vulnerability of large parts of the population (Livanos & Tzika, 2022). In this context, the digital divide and social inequalities are accentuated, with limitations in access, infrastructure, skills and competencies needed to use digital tools revealing to be key issues in the country's progress (FES, 2020). In Greece, an increasing number of uninsured people, long-term unemployment and other factors like staff shortages, lack of medical equipment, long waiting lists etc. add to the persistence of inequity in basic healthcare access (Petmesidou, 2019). In France, despite a good level of overall health, there are disparities between regions and socio-professional categories in terms of risk for certain pathologies and healthy life expectancy. Inequalities concern not only exposure to risk, but also access to healthcare, whether limited by financial barriers or lack of supply. Social inequalities in health are reflected in the onset of chronic diseases, which occur and affect people on low incomes more frequently. Territorial inequalities are apparent in life expectancy,

which is lower in the north and east of mainland France, as well as in the five overseas departments and regions (DROM).

3.5.2. Regional inequality and medical deserts

A related issue is regional inequality, and the phenomenon of medical desertification: Today, 30.2% of the French population lives in a medical desert, and this figure is particularly high in the Île-de-France (Greater Paris) region, at 62.4%, with suburbs and working-class neighborhoods particularly poorly endowed. The shortage of doctors in many French communities is the result of overly restricted recruitment and concentration in the wealthiest areas. The freedom to set up a practice does not allow supply to match demand. Areas with the highest proportion of the population aged over 60 are also those with the lowest density of doctors. Access to specialist care further reinforces the inequalities between centers and outlying areas.

3.5.3. Digital accessibility and health inequalities

The Digital Economy and Society Index (DESI) has been reporting the European Commission´s Member States´ digital progress since 2014. The latest report (European Commission, Digital Economy and Society Index (DESI): Shaping Europe's digital future, 2022) shows that there are improvements in digitalisation among Member States, but there is still much work to get better digital skills to all citizens, including furthering the digital transformation of SME´s and increasing the spread of 5G networks. As noted above, in ageing populations, the users of health care services will increasingly be older persons. This has implications for the design and adoption of patient-centred technologies, with vulnerable groups possibly disadvantaged. Kailanen et al. (2022) found that key vulnerable groups: older people, migrants, mental health service users, unemployed and the "high users" of health services need support and training when using digital health services or they should have access to face-to-face services. It is particularly concerning as approximately 10 per cent of social welfare and health care customers account for 80 per cent of the cost of using social welfare and health care services (a Finnish statistic but similar in other countries).

Attempts are being made to tailor new technology to specifically address health inequalities. For example, in France, Femtech describes all technologies and solutions developed to improve women's health and well-being, with the ultimate aim of reducing inequalities and gender stereotypes in the healthcare sector. Cardiovascular disease is a particularly eloquent example of the impact of gender stereotypes on care. According to a study by the French Federation of Cardiology, 74% of women are unaware that cardiovascular disease is the leading cause of death for women. Heart attacks are perceived as a male pathology. Because they are less well informed, and because their symptoms differ from those of men, women who suffer a stroke

arrive at the emergency department later. The cardiology department at Lariboisière Hospital conducted a study showing that women suffering a myocardial infarction called the emergency services on average 15 minutes later than men.

3.5.4. Trust in organisations and government

Portugal is characterized by low levels of trust in organisations and in technological solutions to healthcare. In Greece, the healthcare sector has evidence of persisting corruption and procurement issues hindering the provision of health services, practices, and supplies, as well as perpetuating the lack of transparency in every stage of the health system (Stamouli et al., 2023). In contrast, Finland is characterized by a high level of trust in public institutions (OECD 2021).

3.5.5. Different impact of environmental change on health

The environment is a major determinant of human health, through a variety of factors: the quality of the environment (air, water, etc.), the nuisances it conveys (noise, insalubrity, etc.), climatic variations, etc. Human activities can also have an impact on health, particularly industrial and urban activities, and technological developments. It has been shown that certain pathologies can be determined, or aggravated, by these factors, and therefore by the environment in which we live. The World Health Organization (WHO) estimates that 23% of deaths and 25% of chronic diseases worldwide can be attributed to environmental and behavioral factors (indoor and outdoor air quality, water quality, food quality, exposure to chemicals, waves, noise, etc.). The effect of climate change on health varies across the countries: Key environmental concerns for health in Portugal include the increasing likelihood of extreme heat (Brito et al, 2022), and health hazards due to air pollution.

3.6. Particular strengths and examples of innovation in digital health area in project countries

3.6.1. Innovation of AI in healthcare

The development of AI is a major challenge for the future of the healthcare sector. It has a wide range of applications (telemedicine, IOT, etc.). AI is starting to be used for structuring patient data, interpreting medical imaging data, and many other tasks.

ConSoRe project, France
An example of AI innovation from France of this is the ConSoRe project (for Continuum Soins - Recherches), set up by Unicancer, the network of cancer centers, aims to organize the massive data collected in the field of oncology. It is a system designed to collect, analyze and structure this data. Combined with a search engine, it enables doctors to identify patients meeting precise search criteria, visualize the evolution of their disease and treatments, locate rare cancer files, and find out whether similar cases have already been treated elsewhere. These data can then be processed by various algorithms. The analysis of medical imaging data is another of the fields most explored by AI.

SUOG project, France
The European SUOG (Smart Ultrasound in Obstetrics and Gynecology) project, led in France by teams from Sorbonne-Université, Inserm and AP-HP, aims to use AI to improve pregnancy monitoring: integrated into the ultrasound machine, this program will be able to suggest in real time to the practitioner the images he or she needs to take to make a diagnosis in the event of suspected pathology. This will also facilitate and guide therapeutic management. In the mental health segment.

There are also French AI research programs in the field of prevention. The PsyCARE project (Intervention précoce dans la psychose : vers une psychiatrie préventive et personnalisée), in particular, aims to develop an AI for the early detection of schizophrenia or chronic psychosis, in order to implement preventive and personalized psychiatric care.

3.6.2. Digital platforms, health records and interoperability

Kanta archive, Finland
In Finland, the national Kanta archive manages two services - it functions as a prescription centre and patient data repository. A national archive collects all patients´ data from public and private health care sector. This national archive gives possibility to share data with different care providers. It gives also possibility to citizens to see they personal health data. (Jormanainen, 2023). Citizens can monitor their own health and wellbeing with the My Kanta Pages Personal Health Record (Kanta PHR). The data will also be useful in the healthcare services in the future. (Kanta 2023.)

Health Data Platform, Portugal
In Portugal the Portuguese **eHealth developments** linked all public hospitals and primary care centres with a new Health Data Platform that allowed national access to medical records. The first patient portal was launched in the following year with e-booking for online appointments and a platform where citizens could document and consult their data. In 2015, the NHS

launched ePrescription, an alternative for paper prescriptions later banned in 2020. Also, in 2015, the first telehealth platform was established, and throughout the following years, many more digital solutions were developed and implemented in the National Health System (Mendonca, 2022).

Health Data Platform, Greece
Greece has made progress in the development of digital health solutions, including the implementation of electronic health records (EHRs) and the use of telemedicine to improve access to healthcare services, particularly in remote areas (OECD, 2021). To that effect, the country has been implementing a national eHealth interoperability framework, since 2020 (Ministry of Health., 2021).

Telemedicine, Finland
Finland has a lot of innovation in the use of telemedicine. According to Mikkola (2018) "doctor visits are slowly being replaced by video connections and chat services of remote services. Kela replaces a remote reception visit, but does not replace the chat service as a first visit, which is why it does not appear in the official statistics either." Additionally you can nowadays renew your prescription in MyKanta (Omakanta) health data service portal without the need for a visit.

Mursu, Siira and Vuokko (2022) assessed the digital capabilities of Finnish healthcare system using The European Reference Architecture for digital healthcare and the eGovERA model. In their situational picture they conclude that in prescription and supply of medicines digital capabilities are in place at the local, national, and international level. In fact, the percentage of physician practices that can share information with hospitals about patients' current medications is 100 % in Finland (OECD/European Union 2022, p. 207). The success in international level is derived from recent progress in sharing cross-border the information of medicine prescribed in Finland with pharmacy systems of three different countries. Other strength areas according to Mursu, Siira and Vuokko (2022) were imaging, and laboratory data. The lowest levels of digital capabilities were in the secondary use of patient data.

3.6.3. Advances in mobile health technology

The field of mobile health and wearable technology is being developed in all four countries. Portugal has developed a range of Health data apps, including technologies (personal alarms etc) for older adults at home to self-manage emergencies, hypertension, chronic conditions. Self-management of diabetes, heart conditions (Pereira et al, 2021). Mobile health technologies (mHealth) have also been on the rise in Greece, with the use of mobile apps and wearables to track health and fitness becoming more popular. To that effect, several digital health startups in

Greece are emerging and focus on areas such as health monitoring, medical imaging, and patient engagement. In general the Finnish people is accustomed to using different type interned-based services. The national Kanta archive has successful brought together patients' data from public and private health service providers and is available for citizens' own monitoring. The digital infrastructure of prescription and supply of medicines is also in a high level in Finland. France also has **a** highly developed digital healthcare segment, with the number of companies and investments in the sector growing rapidly in recent years. This variety of companies, ranging from biotech and digital health to AI and medtech, most of which are enjoying strong growth, means that France is able to offer major technological advances in this sector. 52 patents were filed by French HealthTech companies in 2022 (Panorama France HealthTech 2022). Nevertheless, 50% of companies are concerned about the sector's regulatory constraints.

Greece ranks low in digital economy growing rates (28th among the EU countries in 2018), as it allows for significant delays in projects' implementation and in the absorption of allocated funds (Laitsou et al., 2020). However, according to the Digital Economy and Society Index (DESI), the country shows some promising signs and forecasting indicates possible convergence by the year 2035 (ibid.). Greece has been investing in eHealth initiatives, such as electronic health records and telemedicine, to improve access to healthcare services, particularly in remote areas (OECD, 2021). The country has also established an e-prescription system and adapted the corresponding legislative framework (Kani et al., 2017).

4. Results: Participant feedback on Ecosystem mapping

4.1. Theoretical background

Stakeholder collaboration can be examined using the business ecosystem approach. A business ecosystem is defined by Moore (1993) as working cooperatively and competitively with other companies in order to co-evolve capabilities, support new products, satisfy customer needs and incorporate a new round of innovations. The literature on ecosystems is mostly concerned with collaboration among external partners, such as other organisations (Lütjen et al., 2019; Vargo et al., 2015). Organisations forming innovation ecosystems come from diverse industries and include, for instance, competitors, suppliers and universities, aiming to create value for organisations and for customers (Xie & Wang, 2020). The focus of innovation ecosystems research is mainly on external stakeholders and their relationships between each other.

In the innovation literature, co-creation is mostly discussed in relation to the customer perspective but also from the other stakeholder perspectives. Collaboration using co-creation is seen as a central aspect in a joint value creation process to foster and facilitate innovations (Prahalad & Ramaswamy, 2004). Co-creation in the innovation process involves multiple stakeholders combining knowledge (Kristensson et al., 2008) and becoming innovators (Degnegaard, 2014; Sarker et al., 2012).

Ecosystem utilising co-creation has enormous potentiality in health and wellbeing because it is a data-rich and customer-oriented field that deals with interlinked, interdependent, and complex problems (CCO 2023) For example, solving the ageing population problem requires the joint effort of policy-makers, different professionals from doctors to economists and city planners to customers, and end-users. In this equation, citizens are the key actors, as their choices have the capacity to promote good life and wellbeing.

The ManagiDiTH Programme design and planning will be a co-creation work within the consortium, which will build the learning ecosystem around the Master's courses. The aim is to bring up an interdisciplinary learning ecosystem to tackle complex health care problems with interdisciplinary approach to open up the learning ecosystem to students. We will create an interdisciplinary, ongoing learning ecosystem around and beyond the project. The industry connections will allow students to develop research projects that contribute to the digital transition process of the health sector. Ecosystem mapping will enable knowledge creation

between quadruple helix partners, where the project partners can be facilitators in each region, and also across the different countries.

In ManagiDiTH we define ecosystem as an innovation ecosystem: an evolving set of actors, activities, artifacts and relations, encompassing complementary and substitute relations, that are crucial for innovative performance. This notion of co-creation within an ecosystem framework was introduced to participants for discussion in focus groups and interviews, using the following diagram. The global networks are an important part of ecosystem work. Echalliance is the global health connector, which connects different kind of actors, data and ecosystems (ECHalliance 2023).

Figure 2. Ecosystem Mapping diagram 1 (ECHAlliance 2023)

Digital health ecosystems need multidisiplinary, interdiciplinary and even transdiciplinary communication to get good results from research and innovation work. There are more possibilities to develop new innovations in transdiciplinary team work with professionals and students from university, companies and associations around digital health.

4.2. Feedback from participants on the Ecosystem diagram

Questions we asked participants about Ecosystems in their countries included questions about the stakeholder categories in the Ecosystem diagram. Were these relevant to each country, and are there missing or emerging categories? What counts as good practice in ecosystem collaboration? Who are the "orchestrators" in each national ecosystem network?

The increasing digitalization of the health sector emphasizes the understanding of networks and ecosystems. From the different national discussions, and seeing which categories were accepted, discussed or queried in the focus groups, it is clear that the four ecosystems of the four countries are different. This might be a useful tool for teaching the Master's programme students about, as a way of considering national differences in health services. Students could compare pros and cons of different ecosystems. However, at present the international level of the ecosystem is not yet sufficiently established, and that there a tendency of national self-sufficiency in health systems. This is something which could be explored in the Master's degree programme.

4.2.1. What counts as a digital health ecosystem?

In terms of the digital transformation of the health sector, it was noted that digitalisation of administration and management processes is not equal to the creation of a digital health ecosystem, and the whole ecosystem diagram may need to be redrawn to incorporate technological changes (in particular, Chat-GBT was suggested as a major change which would affect ecosystems).

Some feedback was similar in all countries. The ecosystem diagram was seen as comprehensive, broadly including most relevant stakeholder categories, but the details of categories could be revised. Some dimensions were seen as overlapping. However, as focus group feedback and research literature suggest, health and social care systems are typically designed from the perspective of the care providing organization (Mickelsson et al. 2022). Understanding the customer or patient and their life contexts is thus an important, but partly neglected topic of interest (Leino 2017; Mickelsson et al. 2022).

4.2.2. Lack of foregrounding of patients/citizens

A general view was that the patient role is not well represented in the ecosystem diagram. This is in line with recent research on service and customer ecosystems, where it has been argued that a provider-centric approach to ecosystems gives an incomplete picture of health service provision (e.g. Lipkin & Heinonen 2022; Mickelsson et al. 2022). Foregrounding the beneficiary of

service, i.e. the patient, citizen or customer, can instead reveal the complexity of actor constellations around them. In this context, patient associations can play an important role, and they should appear more explicitly. In Finland, it was suggested that the lifecycle of patients should be better included, from cradle to grave, including family, neighbourhood and places like libraries. In France, it was suggested that in reality, the patient is close to some actors (such as health professionals) and far from others (like the data scientists) – the circular diagram does not account for this. These comments also reflect the importance of understanding the end-user and their life contexts, in developing and delivering health care solutions. It was also noted that it might be more appropriate to use the word "citizen" than "patient". It is worth noting that this terminology also reflects the expected roles of actors in health service contexts. While the term "patient" might reflect a passive recipient role, researchers have also pointed out that "health care customers" today have increasingly active roles in co-creating the health care service (McColl-Kennedy et al. 2017). This is especially relevant considering the emergence of new technologies that enable patients/citizens to take on more active roles (McColl-Kennedy et al. 2017).

4.2.3. Operationalisation of the ecosystem

Feedback from the French focus groups was that this figure is a non-operational view of the ecosystem. They suggested it would be more interesting to have a dynamic representation of the system, with flows, relations and links. Also, in their view the diagram as such does not highlight the absence of relations between actors. Information about what is missing could provide directions for health system development.

4.2.4. Limitations of attempting an exhaustive, up-to-date ecosystem representation

Participants noted that it is difficult to have an exhaustive representation of the ecosystem: each category can be split down further (for example, research and education includes very different sub-sections (public research, industry research, health professional education, IT education, initial training, continuing education) which are distinct and not connected in real life. Conversely, patients and health professionals are in two different sectors, but should be highly related to each other. Participants in the Portuguese IT focus group considered this diagram outdated, as many Portuguese providers are now multi-services, moving across different categories (from sponsors to providers, for example, of from policy makers to developers. Some organisations defy categorization. In Portugal, for instance, it was not clear where to include the Serviços Partilhados do Ministério da Saude (SPMS) - "Shared services of the ministry of health" – it could be described as a Provider, an IT developer, a regulator, a policy maker, or even the "Director of the orchestra" for the Portuguese Digital Health Ecosystem.

In the digital era it is important to note that the ecosystem is influenced by actors and action outside the system of formal knowledge production. Participants even suggested that misinformation should be included in the diagram.

4.2.5. Revised ecosystem following national feedback

Based on comprehensive feedback from the focus group interviews, an updated ecosystem map will be developed within Work Package 3. Figure 2 below presents a summary of missing actor types, categorized around the original ECHA Alliance ecosystem map.

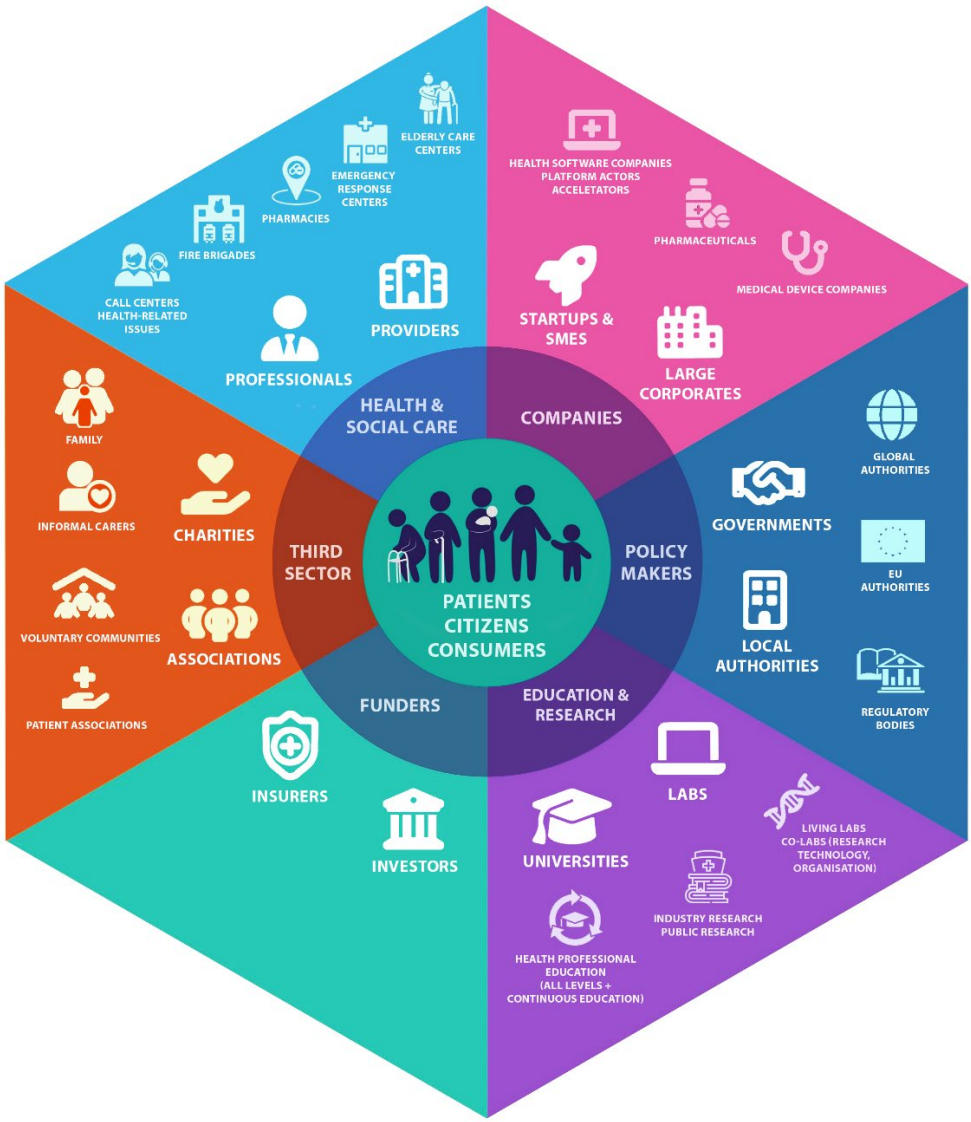

Figure 3.Revised ecosystem mapping diagram

4.2.5.1 Missing: International organisations and networks

In all four participating countries, a lack of global, European and national organisations were noted. Specific organisations to include were:

- The World Health Organisation (WHO)
- The "Health Data Hub" (French health data warehouse)
- Regulatory bodies like the Greek Idika (e-Government Center for Social Security Services)

In general, a lack of connections to international networks was recognized. It was mentioned that one potential approach to learn more would be international benchmarking.

4.2.5.2 Missing: "Everyday life" aspects of the ecosystem

There was feedback from all countries that "Everyday life" should be better visible somewhere, e.g. for children daycare & school are important stakeholders. Same for senior citizens, for whom health and social care were seen as interrelated. Informal carers and voluntary communities are important actors. New categories of Community Pharmacies, Eldercare Centres were suggested.

4.2.5.3 Missing: Business innovation and digital advances

Participants suggested that this diagram could be expanded to include business accelerators, interactions or progression in business areas. Digital breakthroughs are missing, for example:

- It was noted that was that ChatGPT (and similar technological developments) will be tools that soon all stakeholders at different levels will be able to use, which will transform healthcare services (and the ecosystem).
- Living labs and co-labs should be included in the ecosystem as they provide a platform for co-creation between the research community, healthcare professionals, and patients
- It was noted in Greece and in France that pharmaceutical and medical device companies are very different from health software companies.
- Accelerators could be added to the ecosystem

4.2.6. Good practice in ecosystem collaboration

The focus group interviews revealed some good practices – both existing and desired – for collaboration in ecosystems. Ecosystems emerge and evolve in various ways. In general, it was seen that ecosystems form around common and shared benefits, meaning that each actor needs to gain something from the ecosystem. Cooperation is also enabled by mutual goal-

orientation, whereas direct competition between actors can hinder the successful functioning of ecosystems. The importance of collaboration in digital health among the ecosystem stakeholders was recognised in all countries. It was brought up that the different organisations have different assets to bring into the collaboration. For example, patient organisations may not be so abundantly financed but have excellent contacts with patients that they can connect with developers. Companies, again, may have better financial resources to promote solution creation in co-creation.

Two examples of good practice in ecosystem collaboration are from Greece (see boxes on the next pages). In addition to these discrete events, the importance of continuous processes was seen as helpful in effective ecosystem collaboration. This can be enabled through traditional means of communication, such as talking and listening to each other, but also through technological solutions, such as systems that integrate and share data.

Good practice in ecosystem collaboration: the Covid-19 vaccination programme, Greece

The Covid crisis brought out examples of good practice in ecosystem collaboration, for example in Greece this led to collaboration on the covid-19 vaccination programme, resulting in reduced waiting times and better service.

Specifically:

1. **Multi-Agency Coordination**: Greece established a centralized coordination system involving various government agencies, including the Ministry of Health and the National Public Health Organization. These agencies have worked together to plan and execute the vaccination program, ensuring that resources and information were shared efficiently (Delinasios et al., 2021).
2. **Public-Private Partnerships**: Collaboration with private healthcare providers took place to cover the urgent need for *intensive care beds, facilities and wards* (Tsalampouni, 2022).
3. **Data Sharing and Monitoring**: Greece has put in place a efficient system for data sharing and monitoring. This included tracking the distribution and administration of vaccines, monitoring adverse events, and ensuring vaccine coverage data was updated regularly (Delinasios et al., 2021, Georgiadis & Georgiadis, 2021).
4. **Logistics and Supply Chain Management**: Effective logistics and supply chain management are vital. Greece managed to coordinated the procurement, storage, and distribution of vaccines to vaccination centers across the country, minimizing delays and ensuring a steady supply of vaccines (Tsalampouni, 2022).
5. **Community Engagement and Communication**: Greece engaged in extensive public awareness campaigns, utilizing various communication channels such as television, radio, social media, and official government websites. Clear and accurate information about the vaccines, the vaccination process, and the importance of vaccination has been disseminated (Vildiridi et al., 2021).
6. **Data-driven Decision Making**: Public health officials were regularly analyzing data on vaccination rates, vaccine effectiveness, and the prevalence of COVID-19 variants to adapt their strategy. Decisions on booster shots, changes in eligibility criteria, and other adjustments have been data-driven (Delinasios et al., 2021, Vildiridi et al., 2021).
7. **Prioritization and Equity**: Greece followed guidance from the World Health Organization (WHO) and other relevant authorities to prioritize specific population groups for vaccination (e.g., healthcare workers, the elderly, and individuals with underlying health conditions) to ensure equity and protect those most at risk (Vildiridi et al., 2021).
8. **Feedback Mechanisms**: The Greek government established mechanisms for collecting feedback from healthcare providers and the public. This feedback would helped identify any challenges in the vaccination process and allowed for swift corrective actions (Vildiridi et al., 2021).

Good practice in ecosystem collaboration: The refugee crisis, Greece

The refugee crisis in Greece was highlighted in focus groups as an example of effective collaboration between stakeholders to address the humanitarian challenges, with an immediate and efficient response. There was internal management and organization without much intervention from the government. Among the examples of good practices in ecosystem collaboration that emerged during this crisis are the following:

1. **Non-Governmental Organizations (NGOs):**
   - Numerous NGOs, both local and international, played a crucial role in providing humanitarian assistance (Valvis et al., 2021). Organizations like Médecins Sans Frontières (Doctors Without Borders) and the Red Cross established medical clinics and distributed essential supplies to refugees (Médecins Sans Frontières, 2023; Red Cross, 2023).
   - NGOs collaborated with each other to ensure efficient use of resources and to avoid duplication of efforts. They also worked with local communities to build support networks (Valvis et al., 2021).
2. **Local Communities:**
   - Greek communities in affected areas demonstrated resilience and solidarity by offering shelter, food, and support to refugees (Fotaki, 2021). They organized volunteer groups to assist with various needs, including translation services, childcare, and transportation.
   - This grassroots support was a critical aspect of the response, highlighting the importance of community engagement and collaboration (Kanellopoulos et al., 2020).
3. **International Organizations:**
   - The United Nations High Commissioner for Refugees (UNHCR) played a key role in coordinating the response, providing funding, and offering technical support to Greek authorities (Tramountanis et al., 2022).
   - Other international organizations, such as the International Organization for Migration (IOM), partnered with Greece to address migration-related challenges (ibid.).
4. **Local Government Authorities:**
   - Local municipalities in Greece worked with NGOs and international organizations to set up reception centers and provide essential services (Tramountanis et al., 2022). They often had to adapt quickly to changing circumstances.
   - Collaboration between local and national government authorities allowed for more effective coordination of resources and support.
5. **Frontline Workers and Volunteers:**
   - Volunteers from various backgrounds, including medical professionals, teachers, and translators, collaborated to provide assistance (Cabot, 2019). They offered language skills, medical expertise, and educational support to refugees.

- Frontline workers and volunteers received training and resources from NGOs and government agencies to enhance their effectiveness.

6. **Private Sector Engagement:**
   - Some businesses and private individuals provided financial support, donations, or resources to aid in the response effort. This engagement helped bridge gaps in resources (Kalogeraki, 2019).
   - Collaboration with the private sector extended to transportation and logistics, ensuring the efficient movement of humanitarian aid.

4.2.7. Orchestration of the ecosystem network

There was variation in responses about who might be the orchestrator of an ecosystem, and whether one was needed. In Finland, the view emerged that a facilitator is absolutely needed, with a leader needed to ensure progress. In Greece it was suggested that orchestration should be led by a public health organization with links to academic institutions, as well as European entities, that serves as an umbrella organization. It is a federation of entities involved in public health, healthcare, and analytics. Other Greek respondents thought that orchestration should be by a combination of health care providers, government and third sector (charities and associations). In Portugal, it was suggested that the "Director of the Orchestra" in theory is the citizens/users.

5. Implications of Skills Need Forecasting activity for the Master's programme design

In this section we provide a summary of the key implications we have drawn from feedback from the focus group and interview participants, plus the desk review, for the design and implementation of the Master's programme: We especially consider the core graduate skills, knowledge and experiences for EQF level 7 which we should design the programme around. We started with an outline Master's programme structure, from the project proposal (Figure 3).

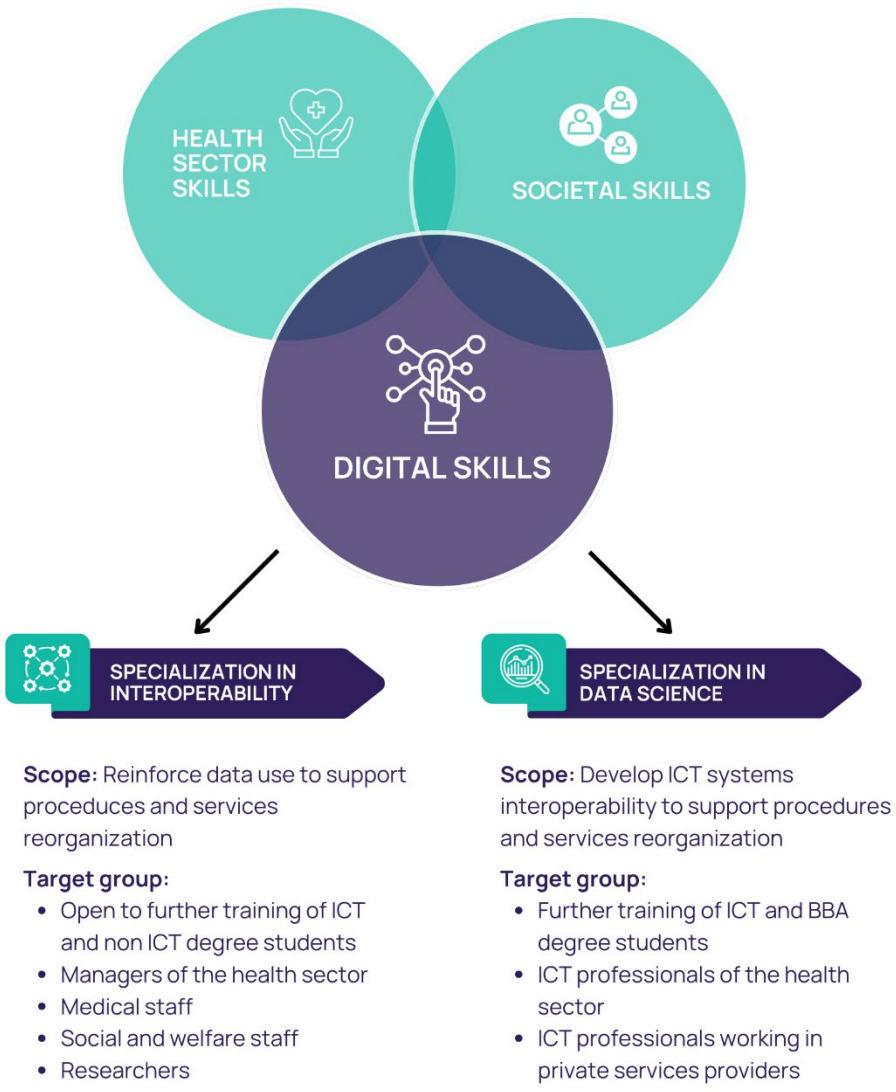

Figure 4.Master's programme design

After analysis of the skills need research data, we amended the programme design to the structure outlined in the project website https://managidith.eu/

In the following sections, we consider the feedback for the programme design in general, and then specifically for the three main areas of the Master's programme: Social, Health and Digital sectors.

5.1. Overall recommendations

5.1.1. International competency frameworks

The importance of aligning the programme with recent and developing competency frameworks in digital health was highlighted. It was noted that if all schools are committed, then it is possible in future for students to apply for international accreditation. For this it was suggested that we base the curriculum/education on the International Medical Informatics Association (IMIA) competency framework (https://www.sciencedirect.com/science/article/abs/pii/S1386505622002222), reviewed by Bichel-Findley et al (2023), and the related Biomedical and Health Informatics (BMHI) core principles (https://www.theseus.fi/handle/10024/157452). To address this need, the project has drawn up a framework of the relevant IMIA competencies, and is mapping the skills, knowledge and experiences set out in the curricular unities against the wider competency framework.

The ManagiDiTH programme draws on related research, including the LEADS consortium revised framework for advanced digital skills (ADS) This recently revised (LEADS, 2022) framework includes advanced skills related to the Internet of Things (IoT) Application, Orchestration and Robotics. The LEADS consortium has also identified the need to include advanced skills related to cloud, AI and IoT sustainability.

5.1.2. Key strengths and omissions of the Master's programme

5.1.2.1 Key strengths which should be drawn out more strongly

Focus group and interview participants suggested key strengths of the proposed programme which they thought should be drawn out more strongly, and highlighted in any publicity or promotion or recruitment. These key strengths were implicit in the programme design, and included in the project proposal, but we note it is critical to continue to focus on these aspects of the programme in marketing and development of course content. These include:

5.1.2.1.1 Interdisciplinarity and Multidisciplinary

It was noted that these are major strengths of the Masters and ways to encourage this in the structure of the programme at various levels are important.

5.1.2.1.2 International focus.

As well as being interdisciplinary, the benefits of being on a European-wide programme need to be drawn out more strongly, e.g. the planned use of international virtual classrooms, cross-national problem solving activities.

5.1.2.1.3 Focus on placements and practical work experience

Participants were very keen that the curriculum should include practical training and placements to ensure that graduates can apply their knowledge in real-world situations.

5.1.2.2 Overall gaps and omissions suggested for consideration

5.1.2.2.1 Patient involvement

Feedback from participants was that patient involvement is not currently very evident in development and plans. This echoes the participant feedback about the ecosystem diagram and lack of centrality of the patient experience. Patients need to be more involved in master design and in curriculum, throughout. In the recent development of the curricular unities there has been focus on patient involvement, but the impact of this should be monitored over the pilot stage of the programme. For example, the programme might develop an Expert by Experience (patient) group to support student project development.

5.1.2.2.2 Ensuring diversity at all levels

It will be important to consider how to ensure **diversity** in this Master's programme, both in recruitment of students to the programme (a diversity/gender equal quota was promised in the Proposal), and in focus on teaching and research to include diversity issues. As with the previous point, the development of curricular unities content has included specific focus on this issue for teaching content. Focus group participants suggested including "multicultural skills" in the programme – in the ManagiDiTH Master's programme this is being addressed at the programme delivery level. In all parts of the programme, students will study and work in a multicultural context, both online and in summer schools. In addition, some curricular unities include specific content on cultural issues and diversity, for example, the course on Healthcare Resource Management (CU2) includes content on how to support diverse patient groups.

5.1.2.2.3 Changing terms, concepts and priorities in the digital health field

It is necessary to be very clear on the definitions of the different terms and expressions used to define the area of the master's: terms include e-health, digital health, connected health, medical informatics, remote health practices, telemedicine. Even within the four years of the project, terms and language are changing. Some courses have already had their names and descriptions updated. We are drawing on research by related projects, notably LEADS (2023) who have been updating their framework of Advanced Digital Skills including new groupings and terminology.

5.1.2.2.4 Micro-credits, short courses, and double certification options

Would there be an option for micro credentials/double certification – ECTS and IT relevant certifications – for short term courses? This was viewed as important in Portugal, where it was suggested that IT professionals who may not have time for a full Master's programme might be interested in certain courses. This idea will be considered during the piloting and evaluation of the programme. When in the study unit we have six credits, it might be possible within this study unit to have, for example, three credits for automated studies, which can be taken as micro credentials from every study unit.

5.1.3. Implications of Ecosystem discussions for Master's programme design

5.1.3.1 Need to cross sector silos

Participants were clear about the pressing need, and expectations, for ecosystem stakeholders to learn how to work together. The existence of silos in different sectors was noted in all countries, and the need for a digital health focus to cross these silos is clear. Moreover, as noted earlier, national perspectives on the ecosystem tend to ignore the increasing importance of international bodies and networks, Patients and health professionals need to understand the principles of available technologies. Health professionals need to learn how to use the available tools to manage their patient's care pathway and collaborate efficiently with other healthcare professionals. Meanwhile, digital experts – including IT graduates - needs to understand human (patient and healthcare worker) interactions with technology.

5.1.3.2 Need to involve patients and citizens more fully

The end-users, that is patients and citizens, need to be more deeply involved in the conception and development of IT solutions. Interdisciplinary professionals and citizens collaboration gives fruitful platform to develop new digital health solutions.

5.1.3.3 Ecosystem diagram as a tool for teaching and discussion

The Ecosystem diagram could provide a useful way of considering interaction between different aspects of the ecosystem, and would be a good tool for use in teaching about national and international differences in health care.

5.1.4. Feedback from focus groups and individual interviews on the Master's programme design: Social, Health and Digital sectors

5.1.4.1 Suggestions and discussion around societal and soft skills

5.1.4.1.1 Connection and communication skills

When questioned about the greatest assets students can learn in this Master's programme, the respondents often talked about the importance of connection, communication and social skills. In particular Interdisciplinarity; multidisciplinary teamwork was viewed as essential, including team-working and integration including health professionals, IT professionals, patients. It was seen as a huge strength to be able to create European connections by working with people with different backgrounds in groups. Furthermore, learning how to communicate properly and having digital skills will help the relationship between the healthcare professionals and the patient. The importance of listening and working with citizens (patients, stakeholders) was also mentioned. In the implementation model of ManagiDiTH Master studies the teachers' interdiciplinary teamwork provides a fruitful platform for both teachers and students to learn interdiciplinary teamwork.

5.1.4.1.2 Digipedagogic strategy with focus on blended learning and cross-European virtual classrooms

The ManagiDiTH programme will have a separate digipedagogic strategy which will have a strong emphasis on interdisciplinary learning with many activities planned across disciplinary and national boundaries. Many of the "soft", societal and communication skills recommended by focus group and interview participants are embedded in the design of learning and assessment activities in the Master's programme.

An interdisciplinary learning ecosystem (Figure 4) gives possibilities to students, teachers and other stakeholders to learn and create new innovations with cooperation. For the planning and delivery of the programme, the partner universities will apply a constructivist pedagogy in which students learn science and develop critical thinking skills by solving real-world problems. The pedagogical approach builds on trialogical learning which brings together different levels of learning: monological, dialogical, and trialogical. Monological learning takes place within one's

mind and refers to individual knowledge acquisition. In a dialogical situation, learning takes place in social interaction and meaning-making. In trialogical learning, the learners operate through analysis, construction, and creation of new knowledge and shared objects. (ManagiDITH´s pedagogy strategy 2023; Paavola & Hakkarainen, 2021).

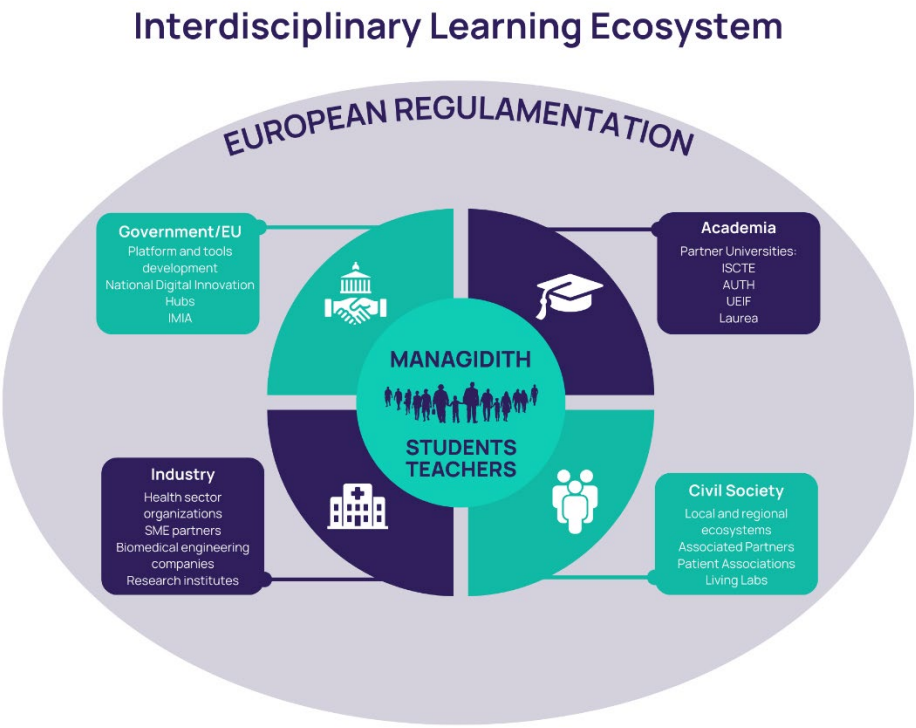

Figure 5.Interdisciplinary learning ecosystem (ManagiDiTH, 2023)

Details of learning has been studied in literature on living labs (e.g. Puerari 2018) which can be understood as a form of open innovation ecosystems (Curley & Salmelin 2018). Living labs can be seen as sites for experimentation and learning in multi-actor partnerships (Puerari 2018). The living lab approach is based on user-centred, real-life problem-focused approach to research and innovation (Ståhlbröst et al 2013). The living lab collaboration may utilize the quadruple helix model of innovation that encourages inviting participants of academia, government, industry and citizens to co-create solutions to topical urban and societal problems (Carayannis & Campbell, 2009). The idea is that by working together the commitment to changes can be increased, the uptake of solutions made faster, risks shared, and resources pooled (Curley 2013).

In living labs learning is related to the activity of research and seen as a collective effort involving reflection. Also, possibilities for learning can be a motivating factor for citizens to participate in co-creation in living labs. (Ståhlbröst 2013.) The thinking behind living labs and open innovation

ecosystems shares roots. Both the living lab and the open innovation ecosystem approach link well with the idea of interdisciplinary learning ecosystem.

5.1.4.1.3 Change management

Change management skills were recommended for the programme. Graduates in digital health will need the capability to adopt change, to be open-minded about innovations, and adapt to fast changing sector, and world. This is being addressed across the curriculum, with dynamic exercises and case studies to encourage students to develop adaptable solutions.

5.1.4.2 Suggestions and discussion around Health sector modules

It was noted that there will be a big distinction in health sector knowledge between the students coming on to the Master's programme. Key aspects which participants felt should be drawn out were:

5.1.4.2.1 Knowledge of different health systems and processes

A central aspect of this international Master's programme will be the opportunity for peer-learning about different health systems organisation and functioning in the EU and beyond. Students will need to have a basic knowledge of clinical practice and models for healthcare in medicine, and the opportunity for comparison between different national systems will enable a critical perspective on this.

5.1.4.2.2 Dual level of competency in use of digital health technologies and tools

Many of the suggestions for health sector skills, knowledge and experience focused on the integration of health data with IT, and with patient-facing skills. For instance, skills in using digital health technology and tools comprises both using them as a health professional, and enabling patients to manage necessary tools for their own healthcare and monitoring. Students were expected to acquire skills to teach or enable patients to use self-management and self-monitoring tools, for the self-monitoring of health data and organization of their healthcare pathway.

5.1.4.2.3 Knowledge and skills around data science and how to represent data to patients

Competency in health data analytics was seen as an essential skill, and this will be addressed in our Master's programme with a new CU officially in the digital sector of the programme, "Health data and information systems", which has been added since the proposal. The ability to represent data into user-friendly formats, and to develop skills with managing, analysing and explaining real-world data (RWD), is something that health professionals will increasingly need to manage, and this is being addressed in various of the CUs spanning health, social and digital

sectors – an example of the integrated nature of many of the skills to be developed on this Master's programme.

5.1.4.2.4 Business skills around marketing and selling health technology

As noted above, there are many developments in digital health products. This means that an important emerging area is marketing, selling, know-how business technology for the field of health care. This also involves understanding international perspectives and markets, so that products can be marketed internationally. Students should develop the capability to spread developed digital services as commercial (export) products.

5.1.4.2.5 Knowledge about national and international regulatory bodies

Related to the above business need, there is an increasing awareness of the need for international and national knowledge around regulatory bodies and legislation. Relevant regulatory bodies include the European rights to Health – with associated referencing networks and procedures.

5.1.4.3 Suggestions and discussion around Digital sector modules

5.1.4.3.1 Digital literacy

It was noted that, while IT graduates will arrive on the programme highly skilled in technology, many health professionals lack even basic computing and data management skills. While courses are planned to be accessible at various levels, in line with the feedback from focus group participants, we took the decision to divide the digital sector modules into separate courses for those students who arrive with good IT skills and those who will need a more basic introduction. In the digital courses, a distinction has now been made between entry-level courses, and more specialised IT courses requiring prior digital expertise. New curricular unities have been added in line with this programme revision.

5.1.4.3.2 Interoperability

A topic that came up repeatedly in the focus groups is the increasing importance for interoperability of systems, including systems external to the health sector such as social care systems and services; patients' associations, users' devices. This emerging issue was also noted in the LEADS (2023) report. The Master programme has had from the proposal stage the option of two key pathways in the digital sector modules, Interoperability and Data Science. Following feedback, plus input from experts and teachers across the ManagiDiTH consortium, students will have both higher level and entry level options in either data science or interoperability – thereby making it easier for all students to access either pathway.

5.1.4.3.3 Ethics in technology and AI

An area which is covered by a separate CU in the Master's programme is ethics in health. The recent developments in generative AI, particularly Chat-GBT, was a topic of interest in the focus groups. It was felt that this should not be limited to an optional module. This is an example of new technology emerging and becoming more salient over the lifecycle of the project, and a reminder that education and training programmes in digital health need to be agile in incorporating changing technology.

5.1.4.3.4 Data security

The importance of data security when dealing with patient data and records is viewed as both important, and sensitive. With systems needing to operate across national borders, data security developers and users need to have knowledge about sovereignty and international regulations on data management and data protection.

5.1.4.3.5 Continuous modelling

Data Science specialisation is broad and should prepare people to think about continuous modelling, including teaching students how to anticipate and adapt to rapid future technological changes.

5.1.4.3.6 Skills in drafting technical specifications in an easy-to-use and functional way

It was emphasised that IT graduates in digital health would need skills in developing easy-to-use and functional solutions in compliance with regulations and standards, and in tune with the needs, expectations and constraints of the end users.

5.1.4.3.7 Importance of specialized education in trending scientific fields

The opportunity for students to specialise, within the Master's programme, into important and newly developing fields was highlighted. Areas which students should be able to specialise in include cybersecurity, ICT systems, and data science.

5.1.4.3.8 Data security for healthcare

The crucial role of data security in digital health makes this a central aspect of the Master's programme, including knowledge about sovereignty and regulations on data management and data protection.

5.1.4.3.9 New (common) language structures

Participants argued that it was vital for IT graduates to understand new common language structures, and to develop skills for developing and adopting new formats.

Feedback on work experience/placement suggestions

1. Students could spend a day or two in digital companies or in health organisations (either public or private).
2. Projects should be developed by mixed groups of ICT/healthcare background students.
3. Multidisciplinary work group sessions between students. There is a great demand to stop working in silos, to work across disciplinary boundaries.
4. There are suggestions for a long placement period, e.g. 3-6 months.
5. Placements could be in primary health care and emergency care, in hospitals, in university departments.
6. Would it be possible to split placements in different professions and focus on interdisciplinary connections.

Feedback on possible research areas for Master students

General feedback on the research component of the Master's programme include:

1. Interdisciplinary and international connections should be prioritised wherever possible.
2. Projects could, or should, be developed by mixed groups of ICT/healthcare background students.
3. We should encourage international project teams and European health related topics.

Some research project ideas include:

1. Research on the effectiveness of digital health solutions in the country, especially in the areas of telemedicine and electronic health records (EHRs).
2. Research on the establishment of interoperability frameworks to ensure better services and cost control.
3. Research on the ethical and legal implications of digital health, including data privacy and cybersecurity issues.
4. Research on the impact of digital health on health outcomes and healthcare costs.
5. Digital platforms and knowledge resources such as Health Village, national ehealth services, efficiency compared to traditional health care.
6. Research on the possibilities, challenge, and ethical issues around generative AI (ChatGPT and similar technological developments).

6. Summary and Conclusions: Trends, challenges and opportunities for the digital health sector

While there are a number of recent studies of technological innovation, and of changes in the health sector, the ManagiDiTH project is unique in focusing on the intersection between these two major sectors. This Skills Need Report focuses on recent and predicted changes, drawing on recent research in four European countries, and combining this with the views and expertise of a range of stakeholders who are at the forefront of developing, implementing and experiencing the digital transformation of the health sector. This multidisciplinary approach, drawing on experts and stakeholders working in the health and digital sectors, is particularly important in envisaging a more interconnected future ecosystem – it is clear that disciplinary and professional silos will be unable to cope with the anticipated needs of the health sector due to the digital transformation. Our focus on current views of working experts, professionals, services providers and service users, also ensures that our focus is fixed on practice, implementation and patient experience, rather than more theoretical approaches.

This report synthesises the different perspectives and knowledge in this field, with the aim of influencing policy, practice and programme design in the crucial and fast-growing sector of digital health.

The ManagiDiTH project has a specific focus on developing a new international Master's programme, but the study findings are also relevant for design of future education and training programmes at a range of levels in the fields of health, social science and IT.

Important trends to consider in managing the transformation to digital health, and ways in which the digital transformation of the health sector may affect or address these, include:

6.1. Social and demographic trends with major implications for health services

The trends identified in this study are in line with widely observed demographic and social changes across Europe. Of particular relevance to the digital healthcare context:

6.1.1. Ageing populations putting pressure on health service provision and budgets

All four countries have ageing populations, with low birth rates and increased life expectancy, putting pressure on services, and also pressure on budgets as the proportion of working age (taxpaying) adults becomes lower compared to the proportion of older, retired citizens.

6.1.2. Generational shift towards higher levels of education and qualifications

In all four countries, and more widely, young adults are increasingly completing higher education and gaining qualifications and skills. Persistent shortages of health and digital sector staff may be matched by the generational shift towards training, education and qualifications.

6.2. Trends in healthcare provision and possibilities for digital transformation

6.2.1. Shifts towards dual systems of healthcare and a mix of public and private providers

An increasing tendency to dual systems of healthcare. Public health services are augmented by private health and social care services. Details of these vary across the countries studied, in some countries insurance systems (either employment-based or individual policies) and in other countries a rise in private payment for health or social care needs. Importantly, this public/private providers leads to a digital gap, with private sector organisations tending to have better technological solutions.

6.2.2. Increased technological capacity and acceptance of telemedicine

There is a rise in digital health provision and use in all four countries. This was sped up by the covid-19 pandemic, and has led a significant increase in technological awareness, and in proficiency of use of a wide range of technology, especially in telemedicine (virtual consultation) in healthcare professionals, and in service users.

6.2.3. Digital health management trends

The rise in long term conditions and comorbidity related to ageing populations is increasingly being addressed by digital solutions, such as self-monitoring of patient conditions.

6.2.4. Staff shortages, burnout and skills gaps

In all four countries, the pressure on health services from ageing populations and increasing expectations of high quality medical services have been exacerbated by the extreme pressure on health and social care staff during the covid-19 pandemic. This study suggests that the transformation to digital healthcare may relieve this problem in two ways, both by increasing training opportunities for staff to work in digital health, and by providing technological solutions which may free up healthcare staff from some activities.

6.3. Key gaps and challenges for the transformation of digital health

6.3.1. Digital accessibility and equality

The high levels of health inequality noted in three of the four countries in the study are a concern for digital transformation. Inequalities due to age, income, region are at risk of being exacerbated by the technological revolution of healthcare systems. The study demonstrates attempts to tailor new technology specifically to address this gap. Examples of good practice in digital accessibility have also been highlighted. However, a major issue to address is that of ensuring that the digital transformation of services results in reducing rather than exacerbating inequalities. The digital divide needs to be addressed throughout design, development and implementation of new technologies, and there needs to be ongoing monitoring and evaluation of impact.

6.3.2. Sustainability of technological solutions

The adverse impact on health of environmental crisis and climate change has been noted. Examples of this include the problem of extreme heat and drought in Southern Europe, air and noise pollution in many cities, and the social pressures of increased levels of migration due to climate change refugees. Technological innovation needs to ensure that it is sustainable in terms of physical resources, energy use and conservation.

6.3.3. Budget constraints

The need to spend increasing proportion of national budget on healthcare has been noted in all countries, and this is not likely to reduce due to the demographic shifts across Europe. In the

digital health sector, there is huge potential to reduce costs, and time pressures for staff, by judicious use of technology, and this will be an important aspect of digital transformation.

6.3.4. The centrality of the patient voice and experience

In the focus groups, the lack of focus on the patient or citizen voice in the Master's programme design was noted. This reflects a broader lack of inclusion of patients, service users, citizens in digital innovation, and in the process of managing the digital transformation. In this study, the co-creation between stakeholders was considered with the aid of an ecosystem mapping diagram and exercise. There is a need to ensure that patient experience remains at the heart of any health system change.

6.3.5. Interoperability across national borders

Another gap highlighted by the ecosystem exercise is the lack of international collaboration and synthesis of technological solutions. The need for interoperability across borders is a core feature of the Digital Europe programme, and is an important feature of training and education, which should lead to international interoperability and closer development of shared targets.

6.3.6. Data security concerns

There are widespread concerns within national health sectors and across wider society about data security, especially concerning patient records. Both healthcare professionals, and IT specialists designing healthcare systems and technologies, need to be competent in understanding and managing the complexity of data protection.

6.4. Conclusions: developing the ecosystem for digital health

We consider that the concept of the ecosystem is at the heart of what we are trying to achieve with the ManagiDiTH Master's programme, and the digital ecosystem is also relevant to developing a broad and inclusive understanding of how to manage the digital transformation of the health sector. The need to move out of disciplinary and professional silos, into a more multidisciplinary understanding, will be essential for future professionals in the relevant digital and health sectors. Our skills need study has highlighted the centrality of integrated systems within healthcare and digital services, but also across different types of health and social care, and across national borders.

6.5. Recommendations

6.5.1. For training and education

- Training programmes are urgently needed to address the skills shortages in both healthcare and in digital skills. Health professionals will need more usability, accessibility and understandability of digital skills, and technology professionals need better understanding about how to deliver health care, especially in international contexts.
- Education in digital skills needs to be in every level of professional education in health and social care, not just at the start of a professional career but there needs to be continuous education and training in new technologies and skills.
- Managers play an important role in leading digital transformation, and in requiring all professional groups to have the digital skills needed in their job description.
- Interdisciplinary knowledge, skills and competencies need to be included in all training (whether training is cross-sector/interdisciplinary or not). This will require interdisciplinary groups of teachers.
- Training programmes should work with international competency frameworks (we especially recommend IMIA, 2023) so that graduates have internationally acceptable qualifications.

6.5.2. For equality and accessibility of digital healthcare solutions in line with Digital Europe goals

- Self-monitoring devices and telemedicine should be developed in ways that lessen rather than increase the digital divide.
- Health and social care professionals should be provided with ongoing training and support for the use of technology.
- Technology developers and social partners need to collaborate to ensure everyone in society has the skills to use everyday technology.
- Specific work needs to be done with minority communities, and with vulnerable groups (for example older adults) to ensure materials, technology and communications are acceptable, understood and appropriate.

6.5.3. For digital change within the wider ecosystem

- Patient groups and service users should be included at all stages of development of services, programmes and technology.
- When developing digital services, the change in the entire service process must be taken into account. You cannot just add a digital service on top of existing services.

- There needs to be a common understanding of data structures and possibilities of reusing data in patient´s care, but also knowledge management in organisations and in political decision making in society level.
- Ensure that digital change is stress-tested in advance, audited and evaluated for accessibility and sustainability.
- There needs to be active and open cooperation with different kind of stakeholders of society, to develop sustainable concepts and services to citizens.

6.5.4. For development of digital solutions

- Data security issues cross technology, ethics and national / international regulations
- For serious innovation there should be transdisciplinary research and development groups, not disciplinary silos.
- It is important that professionals learn to use human centric design principles, when they design new digital services.
- Interoperability needs to be developed nationally and internationally, in line with EU regulations rather than national expectations and always following strict ethical principles, including research and development.
- When designing new digital services, students with a technology background must learn:
    - how to identify the right stakeholders for their project
    - the clinical and physiological concepts they handle, in order to process them in the right way
    - how to gather information from end-users and how to validate their solutions
    - the role of each actor in the healthcare sector
    - the role and principles of each digital technology used in the field of digital health
    - how to explain their working methods to engineers
    - the nomenclatures, terminologies, and classifications common to the healthcare field
    - the rules that guarantee the security and protection of health data.
- Digital healthcare solutions must:
    - meet the needs, expectations and constraints of users
    - respect the rules of usefulness, usability and adoption
    - be flexible enough to adapt to the constant evolution of the healthcare field
    - guarantee the security of the personal data they use
    - be validated by clinical studies
    - deliver the performance levels expected by users
    - be easy to explain

  - ensure that they are not a burden, and that they provide a service by improving working conditions, rather than making them worse.
- Digital healthcare solutions should:
  - guarantee interoperability with other existing (past, present and future) systems
  - be robust, reliable, explainable, and perfectly secure
  - allow a use in extreme or poor digital environments and conditions
  - be upgradable and sustainable
  - not change too much the habits of the user
  - not undermine the quality of care, in all conditions.

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8. Appendices

8.1. Appendix 1: Focus group and individual interview study materials

8.1.1. Focus Group Participant Information Sheet

We would like to invite you to take part in a focus group for experts working in the health and digital skills sectors.

Purpose of the Focus Groups

We are developing a new Digital Health Master's programme in partnership with four European universities (ISCTE from Portugal, Laurea from Finland, University Gustave Eiffel from France, and AUTH from Greece). We are developing relevant content for this new Master that will help the graduated students to plan and support the digitalisation of health services and promote the implementation of new procedures and services, supported by information and communication technologies.

This is a European Union funded project, part of the Digital Europe Programme, led by ISCTE, running from 2023 to 2027. We would like to know what you think it is important to include in the training program, in terms of knowledge, skills and attitudes expected to be acquired by the students. This programme will be delivered mostly online with some face-to-face learning activities, such as Summer Camps.

Specifically:

a) We are assessing social, economic and technological trends in the health sector, and their impact in terms of organisational and individual capacities.
b) We would like to explore the ecosystem of future digital skills needs.
c) We would like to analyse health sector trends and qualifications and skills needs, in order to promote future relevance of the training programme.

We want your opinions on how to include these trends on our Master's programme.

We also want to think about how to engage with stakeholders like you, and others, throughout the project lifecycle.

Why have I been invited to take part?

We would like to hear about the experience and opinions of experts and stakeholders in areas relevant to the Digital Health Master's programme.

What would taking part involve?

You are asked to attend one focus group, lasting 60-90 minutes. *[each country add details of Teams/in person etc]*

You may like to read the brief information and diagrames we provide below about our competency framework in digital healthcare, and the concept of the ecosystem. We will be discussing these concepts in the focus groups.

Confidentiality and data management

The focus groups will be recorded, but the recordings will only be used for project development. Any comments or information shared will be fully anonymised. Any recordings, and any transcription or notes taken, will be deleted at the end of this skills need assessment (by the end of the project). Data storage will follow GDPR regulations.

Who is organising the focus groups?

The ManagiDiTH project is funded by the European Union, to develop skills and training in digital healthcare sector. Master of Managing Digital Transformation in the Health Sector (ManagiDiTH) is a four-year project launched in January 2023, funded by the European Union. Eight consortium partners from four European countries are developing a new master's degree programme, called Master of Managing Digital Transformation in the Health Sector. The new integrated and interdisciplinary programme will equip professionals with the competencies needed to develop digital services in the health sector. We are running these focus groups in the four countries involved in the Master's programme.

Further information and contact details

[each partner add your own contact details here]

Information on key areas we will discuss in the Focus Groups

Some information on a couple of key areas which we would like your views on in the Focus Groups is included below:

1. Information about the Master's programme and competency frameworks
2. Ecosystem Mapping in the digital health field.

8.1.2. Supplementary information: Master's programme design plan and competency frameworks

Introduction

Basic digital skills and education are required for all disciplines in the healthcare workforce.

To fulfil this need, we are planning a curriculum to provide essential skills for health IT and eHealth topics.

We are interested in exploring the skills, experience and competencies which will be essential to equip graduates to work in the transformation of digital healthcare.

There are many relevant competencies and skills. For instance, the **Health Information Technology Competencies Framework - HITCOMP** (http://hitcomp.org/) identifies 1000 competencies in five domains.

1. Direct Patient Care,
2. Administration,
3. Informatics,
4. Engineering/IS/ICT
5. Research/Biomedicine.

In the Focus Groups we would like to hear your opinions what you consider are the **core, essential skills and competencies** for our students to cover in the Digital Health Master's programme. We are especially interested in your experience and thoughts on new trends and emerging areas and jobs needed in your sector.

8.1.3. Supplementary information: the concept of the ecosystem

An important concept which we are using on our project is the concept of Ecosystems.

In ManagiDiTH we define ecosystem as an innovation ecosystem: an evolving set of actors, activities, artifacts and relations, encompassing complementary and substitute relations, that are crucial for innovative performance. Multi-stakeholder co-creation brings together universities, companies, the civil sector and public administration to create new knowledge, develop solutions and disseminate them.

Innovation ecosystem concept describes networks of interconnected actors, working in a goal-oriented and orchestrated manner to generate new concepts, solutions, markets and partnerships. This demands crossing organizational, professional and disciplinary boundaries. Ecosystems users and communities are key sources of new ideas, and we view these as actors as co-creators in innovation. Including users in the ecosystems is essential as it extends the needed knowledge base among the actors and enables a foothold in potential markets.

The co-creation activities in the ecosystem are built around a culture of experimentation and early learning from practice. We will be exploring this co-creation within the ecosystem during the 4-year ManagiDiTH project. For now, we would like to discuss this ecosystem framework and hear your views on it in the focus groups.

Visualisation of Digital Health Ecosystem by ECHalliance.

8.1.4. Focus Group Schedule

Show Introductory slide explaining the Protection data policy and main features of the focus group (Participants, objective, anonymity and confidentiality, use of data collected.

Introduction of the facilitator(s) and of the project ManagiDiTH

Thank you all for participating in our ManagiDiTH project Focus Group.

Reminder of purpose/aims of Focus Group

We are developing a new Digital Health Master's programme in partnership with four European universities (ISCTE from Portugal, Laurea from Finland, University Gustave Eiffel from France, and AUTH from Greece). We are developing relevant content for this new Master that will help the graduated students to plan and support the digitalisation of health services and promote the implementation of new procedures and services, supported by information and communication technologies.

This is a European Union funded project, part of the Digital Europe Programme, led by ISCTE, running from 2023 to 2027. We would like to know what you think it is important to include in the training program, in terms of knowledge, skills and attitudes expected to be acquired by the

students. This programme will be delivered mostly online with some face-to-face learning activities, such as Summer Camps.

Specifically:

a) We are assessing social, economic and technological trends in the health sector in [country X] and their impact in terms of organisational and individual capacities.
b) We would like to improve our understanding of the ecosystem for digital transformation of the health sector.
c) We would like to think about which are the most important health sector trends to be aware of, and which are the key qualifications, skills and competencies needed, so we can best design our Master programme.

We also want to think about how to engage with stakeholders like you, and others, throughout the project lifecycle.

Section 1: Digital healthcare: issues, competencies, needs, trends

1.1 Main issues facing the healthcare sector

What do you think the main issues facing the healthcare sector in your country are?

Probe:

a) Social,
b) Economic,
c) Technological.

1.2 Current graduate skills and competencies

When new graduates arrive in your organisation (after a Bachelor or Master's programme), what skills and competencies do you think they already have at a good level?

Probe:

a) Health sector graduates
b) Technology sector graduates

1.3 Current gaps in skills and competencies

Which sector related technical skills, and occupations/job positions, do you find recent graduates tend to be lacking that they need in their work?

Probe:

a) Health sector graduates lacking (could probe using list of occupations/job positions, ESCO/ISCO)
b) Technology sector graduates lacking…
c) New occupations that could be developed in the future…

1.4 Key Competencies needed to transform digital healthcare

Show powerpoint with Master's programme diagram, as in Participant Information Sheet. Expain it briefly.

Looking now at our planned Master's programme, you can see we are considering key competencies and skills in areas of Health Sector, Digital skills, and societal skills.

From your perspective, what **skills and competencies** do you need to see in graduates joining your sector?

Probe:

a) What types of knowledge (e.g. technical expertise)
b) What types of skills (e.g. communication, critical thinking)
c) What types of behaviours or attitudes (e.g. teamwork, socio-cultural awareness)
d) What might the exit learning profile from this Masters look like. Which possible occupations/job positions might graduates take (existing or future jobs)?

If helpful, refer here to the 5 HIT competency domains:

1. Direct Patient Care,
2. Administration,
3. Informatics,
4. Engineering/IS/ICT
5. Research/Biomedicine.

1.5 Work experience

What sort of work experience/placements during a Master's programme do you think would be most useful to your sector/organisation?

1.6 Research areas

What research topics do you think might be most relevant to your sector or organisation?

Section 2: Ecosystem mapping

Now we would like to think about what we call Ecosystem Mapping.

Show Powerpoint with Ecosystem diagram on it, as in the Participant Information Sheet. Explain it briefly.

Looking at this Ecosystem diagram:

2.1 Stakeholder categories in the Ecosystem
Do you think that these 12 sectors in this diagram cover all relevant stakeholder "categories" in your country?

2.2 Missing or emerging stakeholder categories
Are there other stakeholder categories which you think we should add to the stakeholder's map? And why?
Probe: categories important or specific to your country. Emerging categories.

2.3 Good practice in ecosystem collaboration
Do you have good examples you would like to share with us about the benefits of working in ecosystems, and with which types of partners?

2.4 Role of ecosystem categories in your country
How do you see the role of the different categories in this ecosystem?,
Probe: is this specific to your country?

2.5 Orchestration of the ecosystem network
In ecosystems, an "orchestrator" identifies needs, and supports innovation and collaboration across the ecosystem network. What sort of person might do this? What kind of role might this involve?

3 Concluding questions

(Select from the questions below what is the most relevant from each FG considering what has been discussed before)

3.1 What would you expect from a Master's programme like this in order to address the needs of your organisation?

3.2 How can we reach the vision of patient-centred transformation of digital healthcare by 2030?

3.3 What do you think is the single most important message you would like our ManagiDiTH project to take note of?

3.4 [If time] Is there anything else that you think is relevant that we haven't asked about?

Thank you for your time.
Your contributions will be included, anonymously, in the Skills Need Forecasting report which will help us design the Master's Programme, published by this autumn 2023.
Contributions from these Focus Groups will also be included in the Final Project report (end of 2026).

If you have any questions or concerns, please do not hesitate to contact us.

8.1.5. Individual Interview Participant Information Sheet

We would like to invite you to take part in an interview for key stakeholders and experts in the health and digital skills sectors.

We are developing a new Digital Health Master's programme in partnership with four European universities (ISCTE from Portugal, Laurea from Finland, University Gustave Eiffel from France, and AUTH from Greece). We are developing relevant content for this new Master that will help the graduated students to plan and support the digitalisation of health services and promote the implementation of new procedures and services, supported by information and communication technologies.

This is a European Union funded project, part of the Digital Europe Programme, led by ISCTE, running from 2023 to 2027. We would like to know what you think it is important to include in the training program, in terms of knowledge, skills and attitudes expected to be acquired by the students. This programme will be delivered mostly online with some face-to-face learning activities, such as Summer Camps.

The objective of this interview is to identify the key trends and challenges in the Portuguese health and digital technology sectors, and to consider how these dynamics influence the competencies needed for future professionals in this sector.

We would also like to think about how to engage with stakeholders like you, and others, throughout the project lifecycle.

Why have I been invited to take part?

We would like to hear about the experience and opinions of experts and stakeholders in areas relevant to the Digital Health Master's programme.

What would taking part involve?

We would like you to agree to one interview, on Teams, lasting up to an hour, at a time of your convenience.

Confidentiality and data management

The interview will be recorded if you are comfortable with that.

If so, the recording only be used for project development. Any comments or information shared will be fully anonymised. Any recordings, and any transcription or notes taken, will be deleted at the end of this skills need assessment (by the end of the project). Data storage will follow GDPR regulations.

If you prefer, we will not record the interview, but notes will be taken instead.

Who is organising the interviews?

The ManagiDiTH project is funded by the European Union, to develop skills and training in digital healthcare sector. Master of Managing Digital Transformation in the Health Sector (ManagiDiTH) is a four-year project launched in January 2023, funded by the European Union. Eight consortium partners from four European countries are developing a new master's degree programme, called Master of Managing Digital Transformation in the Health Sector. The new integrated and interdisciplinary programme will equip professionals with the competencies needed to develop digital services in the health sector. We are running these focus groups in the four countries involved in the Master's programme.

Further information and contact details

Martina Maher, ManagiDiTH project, msmrs@iscte-iul.pt

8.1.6. Individual interview Sampling Framework and procedure

Individual interviews with key stakeholders (3-5 per country), April 2023

Introduction

We are developing a new Digital Health Master's programme in partnership with four European universities (ISCTE from Portugal, Laurea from Finland, University Gustave Eiffel from France, and AUTH from Greece). We are developing relevant content for this new Master that will help the graduated students to plan and support the digitalisation of health services and promote the implementation of new procedures and services, supported by information and communication technologies.

This is a European Union funded project, part of the Digital Europe Programme, led by ISCTE, running from 2023 to 2027. We would like to know what you think it is important to include in the training program, in terms of knowledge, skills and attitudes expected to be acquired by the students. This programme will be delivered mostly online with some face-to-face learning activities, such as Summer Camps.

We also want to think about how to engage with stakeholders like you, and others, throughout the project lifecycle.

Individual interviews to be conducted April 2023 in each country, by project staff.

Sampling framework/Stakeholder mapping for interviews:

- 1 policymaker
- 1 regulator.
- 1 ombudsman.
- 1 director of a medical school.
- Someone with higher level political vision.
- Etc.

Some may already be involved as consortium partners.

Procedure

- 30-60 minute interviews
- Conducted by project staff at each institution.
- Can be on Teams or face-to-face.

- Recorded if interviewee is happy with this, otherwise notes taken.
- We have an interview Participant Information Sheet (PIS) which will inform interviewees about anonymity, confidentiality, data protection.

8.1.7. Individual interview Schedule

Introductions

Thank you for participating in our Skills need forecasting exercise.

Reminder of purpose of interview

We are developing a new Digital Health Master's and would like to know what you think it is important to include.

- We have conducted a series of focus groups with key stakeholders in the healthcare, IT and patient association sectors.

We would now like to hear your thoughts on what you think are the key social, economic and technological trends in the health sector in [country X].

We are interested in your suggestions on how best to include these trends on our Master's programme.

Questions (amend as needed depending on the individual's position and expertise)

1. **Main challenges facing the healthcare sector**
   What do you think the main issues facing the healthcare sector in your country are?

   Probe:
   a) Social,
   b) Economic,
   c) Technological.

2. **Current gaps in skills and competencies**
   Which sector related technical skills, and occupations/job positions, do you find recent graduates tend to be lacking that they need in their work?
   Probe:

a. Health sector graduates lacking (could probe using list of occupations/job positions, ESCO/ISCO)
b. Technology sector graduates lacking…
c. New occupations that could be developed in the future…

3. Key competencies needed

From your perspective, what **skills and competencies** do you need to see in graduates joining your sector?

Probe:

a. What types of knowledge (e.g. technical expertise)
b. What types of skills (e.g. communication, critical thinking)
c. What types of behaviours or attitudes (e.g. teamwork, socio-cultural awareness)

4. What would you expect from a Master's programme like this in order to address the national/organisational/sector needs?

5. How can we reach the vision of patient-centred transformation of digital healthcare by 2030?

6. What do you think is the single most important message you would like our ManagiDiTH project to take note of?

7. How can we continue to engage with stakeholders throughout the project? What would you like to see or be interested in participating in?

8. Is there anything else that you think is relevant that I haven't asked about?

Thank you for your time.
Your contributions will be included, anonymously, in the Skills Need Forecasting report which will help us design the Master's Programme, published by this autumn 2023.
Contributions from these interviews will also be included in the Final Project report (end of 2026).

If you have any questions or concerns, please do not hesitate to contact us.