Research Article

Digital Healthcare Innovations and Idea Management

Elina Mikelsone[1] *, Aivars Spilbergs[2], and Jean Pierre Segers[3]

[1] Idea Innovation Institute Ltd., Latvia
[2] BA School of Business and Finance, Latvia
[3] Hasselt University, Belgium
* Correspondence: mikelsone.elina@gmail.com

https://doi.org/eiki/10.59652/jeime.v2i3.257

Abstract: The aim of the paper is to analyse the global demand development and funding of digital healthcare innovations and also characterise idea management trends in the digital healthcare context. Web-based idea management systems (IMS) fall in line with the growing importance of information communication technologies, the spread of open innovation and co-innovation, etc. Especially systems, which are based on the Internet during COVID-19 have become important tools in all sectors. Plus, over the last few years the changes related to digital healthcare have taken place and now in this context the questions have been raised. How could they be linked with a web-based IMS? What are digital healthcare innovation demands and funding trends? The changes in search habits for health information over the last three years have become statistically significant. The growth of funding volumes has followed these changes because both digital health care and digital therapeutics have increased much faster during pandemic times than before. The growth in 2020 compared to 2019 reached 53.9%, but in 2021 compared to 2020 it even accounted 74.7%. The Asian region and Europe have also seen a sharp increase in the leverage over the past two years, but pre-pandemic levels were significantly lower than in the United States. Average annual volumes of investments in digital health have increased by about 4.2 Bn$ per year in the USA, by about 1.2 Bn$ per year in Asia, by about 0.83 Bn$ per year in Europe and by about 0.15 Bn$ per year in other regions. Such demand and funding could boost new innovations in healthcare with web-based idea management systems by internal, external, and mixed approaches in organisations with active and passive IMS. Plus, IMS could become a tool to create innovations in product or organisational innovation.

Keywords: digital healthcare innovations; idea management; funding analysis; web-based idea management systems; digital medicine

Received: July 1, 2024
Accepted: July 9, 2024
Published: July 11, 2024

1. Introduction

The COVID-19 pandemic has triggered a paradigm shift – it is also referred to as the sense of urgency — for accelerating digital healthcare and well-being innovations, although not all new innovations are directly related to COVID-19. Many of the topical innovations have to do with new findings related to artificial intelligence (AI) solutions. For example, scanning healthcare images for the signs of additional conditions or AI-powered mental health apps, the innovation that combines health data with a personalized remote neurofeedback training to improve sleep or an app that enables at-home hormone monitoring in real-time (Springwise, 2022). These are just few digital healthcare innovations which have been launched recently. The AI business platform model is virtually in affluence with the cloud SaaS model – it concerns AI solutions that can work together on the top layer of other digital systems (Mishra & Tripathi, 2021). One of the key questions is whether the growth in public-private funding followed these changes, and how web-based idea management systems (IMS) may support the ongoing digital healthcare innovations.

A digital healthcare innovation ecosystem has been researched by many researchers and has been highlighted as a very important one. Several studies have underscored its significance (Asi & Williams, 2018; Benedict & Schlieter, 2015; Bhavnani et al., 2017). Research has also examined various aspects of its development and implementation (Chae, 2019; Cheng et al., 2021; Craig et al., 2020). The role of technology and innovation in enhancing healthcare outcomes has been a focus of many investigations (Cripsi et al., 2019; Gjellebæk et al.,2020; Han et al.,2021). Furthermore, the integration of digital solutions in healthcare systems has been explored extensively (Iyawa et al., 2017; Javaid & Khan, 2021; Kraus et al., 2021). Scholars have also looked into the challenges and opportunities within this ecosystem (Petrakaki et al., 2021; Walsh & Rumsfeld, 2017; Abasi et al., 2021). The impact of digital health innovations on patient care and healthcare delivery has been well-documented (Bygstad & Øvrelid, 2020; Kuo, 2011; Laurenza et al., 2018). Additional research has provided insights into the strategic and operational aspects of digital healthcare ecosystems (Raghupathi & Kesh, 2009; Serbanati et al., 2011; Kouroubali et al., 2021). Studies have also addressed the economic and policy implications (Nimmagadda et al., 2019; Oderanti et al., 2021; Ramadi & Srinivasan, 2021). The evolution and future prospects of digital healthcare innovation continue to be a vital area of study (Regan et al., 2009; Segers & Gaile-Sarakne, 2021).

However, in this paper the authors will try to link it with a web-based idea management system potential. Web-based idea management systems (IMS) fall in line with the growing importance of information communication technologies, the spread of open innovation and co-innovation, etc. Especially systems based on the Internet during COVID-19 have become important tools in all sectors. Plus, over the last few years the changes related to digital healthcare have taken place and now in this context the questions have been raised. How could they be linked with a web-based IMS? What are digital healthcare innovation demands and funding trends?

Digital healthcare tendencies were researched in previous research (Bhavnani, 2017; Chae, 2019), but in this paper, the authors will concentrate on the COVID-19 period that was the time of changes in healthcare. Previous studies have laid a foundation by examining various digital healthcare trends and their impact on the industry. These earlier works provided valuable insights into the gradual integration of technology in healthcare systems. However, the unprecedented global pandemic brought about rapid and significant shifts in how healthcare services are delivered and accessed. This paper aims to explore these specific changes, highlighting the acceleration of digital healthcare adoption during the COVID-19 period and analyzing its implications for the future of healthcare delivery.

The application and demand of digital healthcare have been well researched (Andersen et al., 2019; Bennion et al., 2017; Ding et al., 2019; Safi et al., 2018). Previous studies have provided comprehensive insights into the growth and integration of digital healthcare solutions (Oborn & Pilosof, 2021; Chang et al., 2021; Safi et al., 2018). Additionally, these works have highlighted the increasing adoption and the benefits of digital healthcare technologies (Balcombe & De Leo. , 2021; Curfman et al., 2021; Hospodková et al., 2021). Several researchers have emphasized various aspects of digital healthcare demand and implementation (Cremers-Pijpers et al., 2021; Dykgraaf et al., 2021; Keasberry et al., 2017). Further studies have explored patient engagement and technology acceptance in digital health (Kursīte et al., 2022; Lai et al., 2021; Nikkou et al., 2020). However, in this case, the authors will focus on very specific aspects of digital healthcare to address current gaps in the literature.

To fill these gaps, the aim of the paper is to analyse the global demand development and funding for digital healthcare innovations and characterise idea management trends in digital healthcare context. In Figure 1 see the logical framework of the research

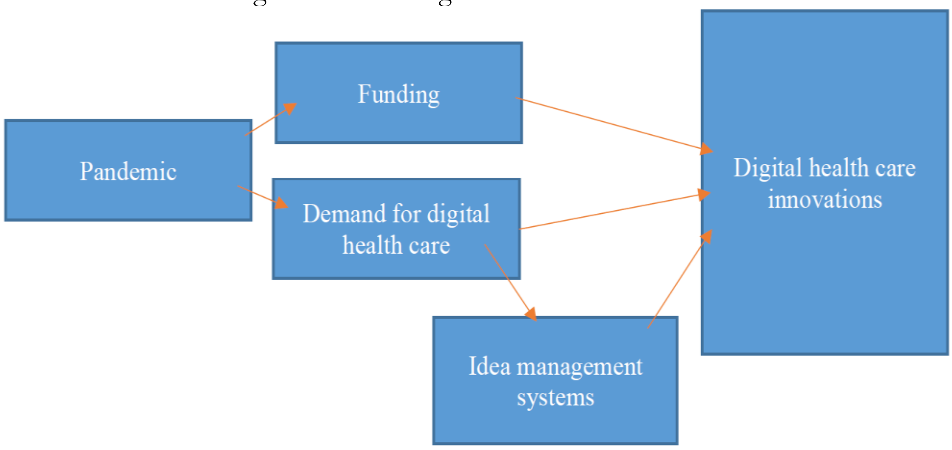

Figure 1. Logical framework.
Source: created by the authors.

By analysing statistical data and case studies to reveal answers to main questions identified in literature:

1. How has the collecting of health-related information changed over the last three years?
2. Has a pandemic boosted the demand for telemedicine?
3. Has an increased demand for digital medical services been supported by the growing funding in these areas?
4. Have some regions been supporting digital medical services by funding more than others? Is this approach data- driven?
5. How could the demand boost new innovations in healthcare by web-based idea management systems?

The paper provides theoretical and practical insights into digital healthcare information that could be relevant for the public and private sectors to follow the demand and funding based on data-driven conclusions.

The rest of the paper is structured as follows. The second section introduces the theoretical background. The third section continues by presenting the research methodology. The fourth section provides the main research findings. This structure can be seen in Figure 2.

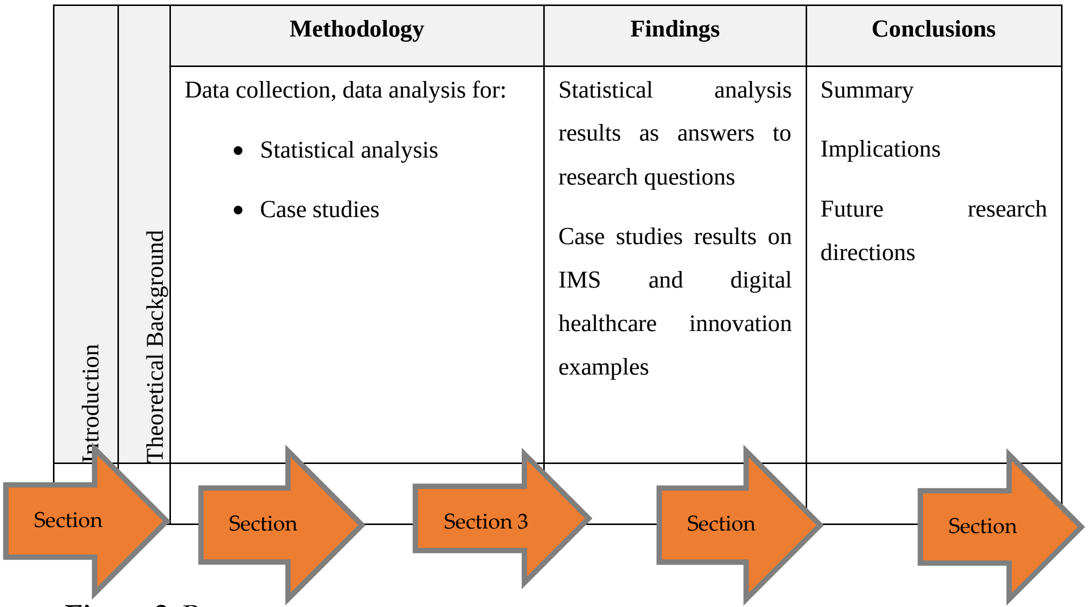

Figure 2. Paper structure.
Source: created by the authors

2. Theoretical Background

2.1. Digital Healthcare and Innovations

Ford et al. (2017) describe digital disruption as a 21st-century phenomenon that has transformed all levels of business and society (Schallmo & Williams, 2018). According to Porter and Kramer (2019), new digital business models will be more efficient and will address not only economic but also social needs with a shared value that will create a great impact on all stakeholders in the network. Reinventing the business models in order to remain competitive (Reis et al., 2018) is very important in this digitalisation era. Also, big data plays a vital role in this transformation by combining data from multiple sources, sharing it with diverse stakeholders, and analysing it in different ways enabling digital transformation (Pappas et al., 2018).

Digital health covers a range of digital solutions (S3 Connected Health, 2020), for example, digital medicine and digital services. They enable new product development and business models to improve the healthcare ecosystem (Segers et al., 2021). Cooperation in the digital health ecosystem is very important to create digital health solutions, connect with specialists at digital health companies, acquire or invest in star-tups, communicate with regulators and patients.

A digital healthcare innovation ecosystem has been researched by many researchers and has been highlighted as a very important one, but in this paper the authors will try to link it with a web-based idea management system potential. There are more and more digital solutions in healthcare that even change stakeholder relationships, which are re-engineered around digital platforms that enhance patient-centred satisfaction and sustainability (Visconti & Morea, 2020). Previous research proves that there are many opportunities of digitalisations, for example, from AI and related technologies perspectives. They could help health and wellness providers to improve the efficiency and to create new value for their patients, but there are also requirements — effective planning and new strategies (Lee & Yoon, 2021).

Vanhaverbeke (2020) has highlighted that innovating through digitalization requires a different approach since digital technologies (AI, big data, etc.) are the base for new digital solutions that change entire business models. Digitalization has been transforming regulated industries including healthcare and this transformation has led to a growing need to establish, scale, and manage innovation ecosystems. Healthcare benefits from digitization by improving coordination between different stakeholders for example, patients and healthcare professionals and organisation, by putting the emphasis of healthcare on prevention more than on cure finding, by integrating data across the entire healthcare ecosystem, by making existing processes more effective and achieving personalized healthcare (Vanhaverbeke, 2020).

In this section digital healthcare innovation is defined as a new or significantly improved product, process, marketing, or an organisational activity in a healthcare industry in the digitalisation context.

2.2. Idea Management

Idea management (IM) can be used by organisations to manage their idea generation, evaluation, and continuation of IM to maximise the full potential of the ideas (Krejci & Missonier, 2021), but in the paper, IM is defined as a “tool, tool kit or a complex system which provides a systematic, manageable process in IM” (Mikelsone et al., 2022;), but web-based IMS are web-based tools that support IM.

There are 3 variants of IMS application types based on the involved sources:

•Internal – an organisation involves in IM only its employees;

•External – an organisation involves in IM external idea creators and/or evaluators (e.g., experts, clients etc.);

•Mixed – mixing internal and external IM approaches.

There are 2 variants of IMS application types based on task focus:

•Active – focused on IM tasks;

•Passive – unfocused on a task/ no tasks, submission of all ideas without any filters (Mikelsone et al., 2022). These types described in Figure 3.

Classifications

Classification criteria: Based on the application focus

Passive IMS		**Active IMS**	
Functions	*Type of focus*	*Functions*	*Type of focus*
Focus on idea generation	Unfocused process	Focus on all IM dimensions	Focused process

Classification criteria: Based on the involved IM source

Internal IMS		**External IMS**		**Mixed IMS**	
Description	*Main IM source*	*Description*	*Main IM source*	*Description*	*Main IM source*
IMS that allows to involve only internal IM sources	Employees	IMS that allows to involve only external IM sources	Crowds, experts, clients, etc.	IMS that allows to involve internal and external IM sources	Employees, clients, experts, crowds, etc.

Figure 3. IMS types.
Source: Mikelsone et al., 2021.

To summarize in this paper IM is defined as an idea generation, evaluation, and continuation of this process, but IMS in this paper will be a web-based tool that could provide an IM process.

3. Materials and Methods

3.1. Statistical Analysis

With the secondary data the authors will try to answer the first research questions. Data selection and analysis process are shown in Figure 4.

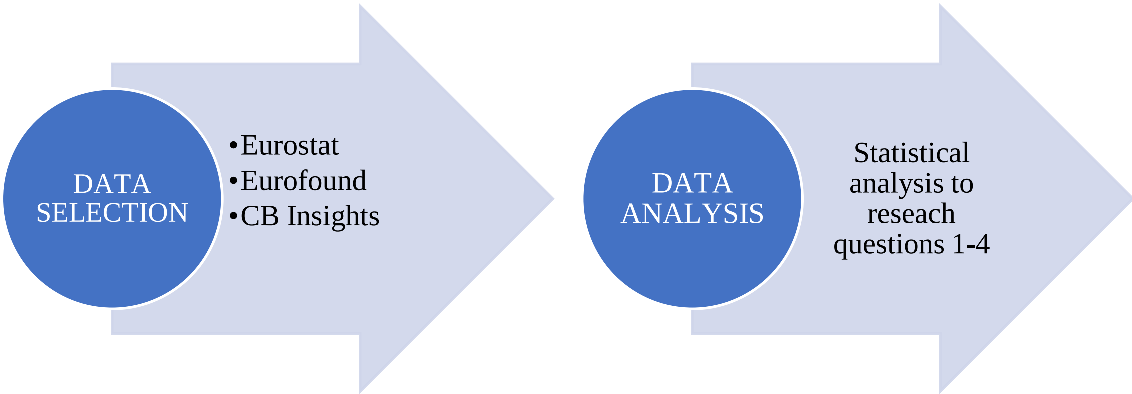

Figure 4. Statistical analysis data collection and analysis.
Source: created by the authors.

Eurostat data (Eurostat, 2022) on the search for health information online has been used to answer the second question of the study. As shown in Figure 5, the leading countries in this field, such as Finland (80%), the Netherlands (77%), Norway (77%), etc. have been considerably ahead of Bulgaria (36%) and Romania (40%). At the same time, there has been varying progress over the last three years. Has the progress been statistically significant during the last three years?

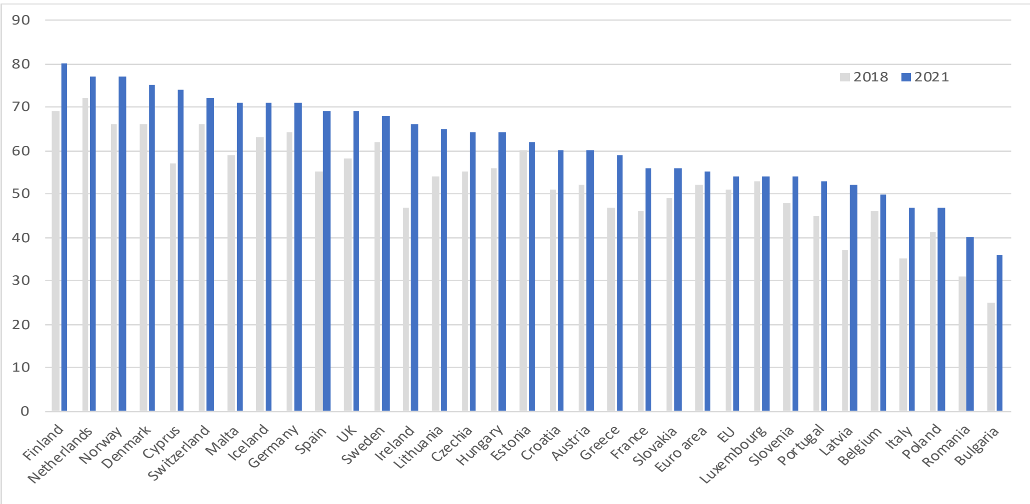

Figure 5. The share of households searching for health information online, 2021 vs 2018.
Source: Eurostat data.

In the European Union, telemedicine services have been also developing rapidly during a pandemic. Eurofound data shows the different level of development of this service, with the countries such as Finland, Slovenia, Poland, Ireland, and Lithuania accounting for more than 50%, while Malta, Germany, and France were significantly below 30% (Eurofound, 2021). See Figure 6.

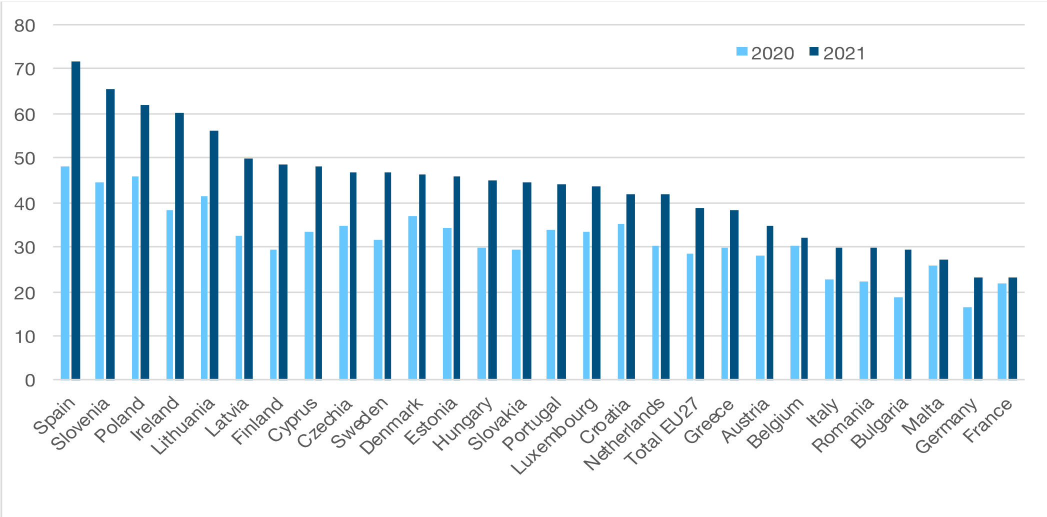

Figure 6. The share of households which received health care using telemedicine, 2021 vs 2020.

Source: Eurofound data.

The chi-squared test was used to assess the statistical significance of the differences in the demand for online health care. Chi-square statistic was calculated as follows:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

where – O_i - observed year 2021 share of online health care;

E_i - observed share of online health care in a base year.

The decision rule applied: If >, differences in the demand for online health care services were statistically significant at the chosen confidence level (0.95), otherwise - statistically insignificant at the chosen confidence level (0.95).

Data from CB Insights were used in the study to explore the interconnections between the increase in demand for online health care services and investment in digital medicine. See Figure 7.

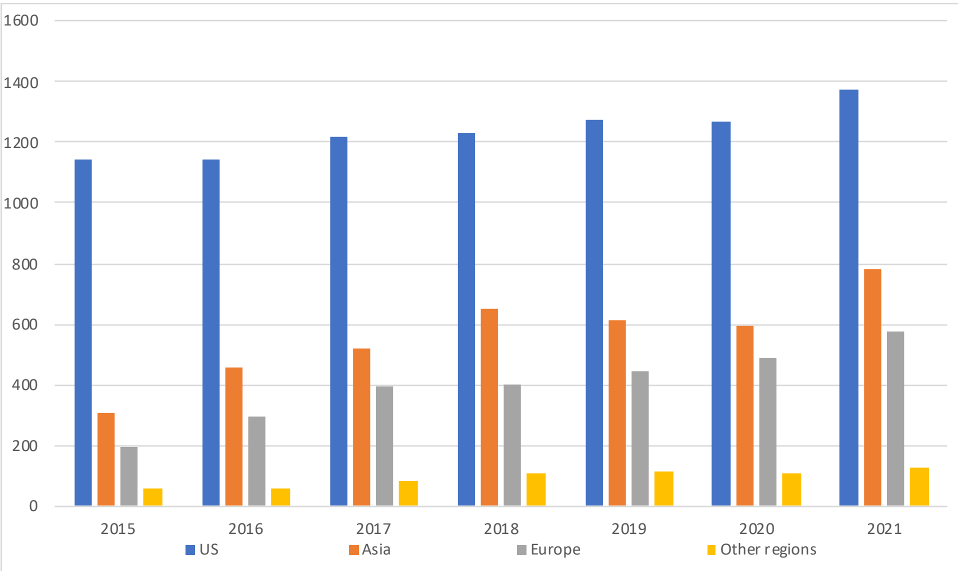

Figure 7. Digital health care funding deals by regions during 2015 – 2021.

Source: CB Insights.

As shown in Figure 7, the intensity of investments in the United States was significantly higher than in the rest of the world, but the development trend was markedly increasing both in the Asian region and in Europe.

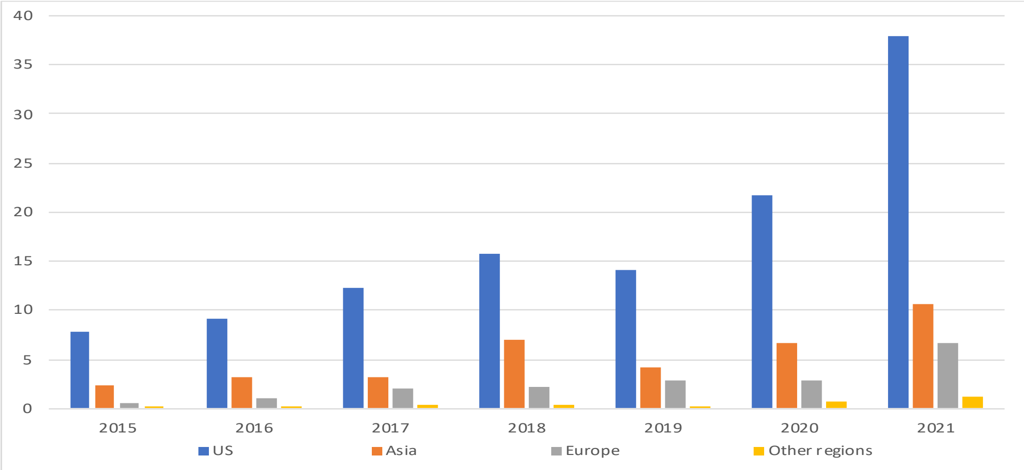

Figure 8. Digital health care funding volumes (Bn$) by regions during 2015 – 2021.
Source: CB Insights.

As one can see in Figure 8, the volumes of attracting digital medicine funding in the United States show a particularly rapid increase during a pandemic - the growth in 2020 compared to 2019 reached 53.9%, but in 2021 compared to 2020 was even 74.7%. The Asian region and Europe have also seen a sharp increase in leverage over the past two years, but pre-pandemic levels were significantly lower than in the United States.

Regression analysis methods were used to study development trends in digital health funding and differences by regions. See the results in Section 4.

3.2. Practical analysis

To overview the existing situation with innovations the authors have selected Springwise.com database. It helps not only to see the trends in innovations but also it provides innovation case documents. In Figure 9 see the data collection and data analysis methods.

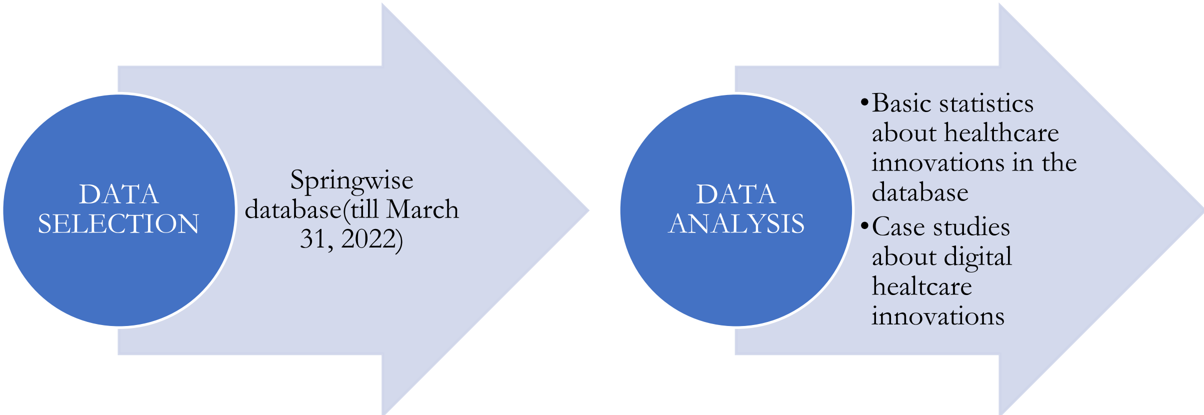

Figure 9. Innovation analysis data collection and analysis.
Source: created by the authors.

In order to analyze cases, the results of which have been processed through a content analysis (see Table 1).

Table 1. Case study steps

Data gathering method	Data analysis method	Time Period
Case studies	Content analysis	2010-2022

Source: developed by the author.

Case study analysis steps:

- Step 1 – The analysis of 5 out of 1007 (more recent, digital innovations, diverse ideas) case analysis documents based on full and complementary information and individual communication available on IMS websites.

- Step 2 – The contented analysis of the materials obtained. This step fills in and analyzes information in case analysis protocols. A protocol is designed as a category map that makes it easy to analyze. The category map elements (see Table 2).

Table 2. Category map for case study

Basic	Name
	Country
	Year
	Creator (private sector, academic sector, public sector)
Innovation description	A problem that innovation has been solving.
	A product user (patients, society, hospitals, specific)
	The description of the innovation
	Innovation type based on results (product, process, marketing, organisational)
	Open/Closed innovation/no information

Source: developed by the author

Step 3: Creating and comparing case descriptions.

Springwise has the representative data from 1007 health and wellbeing innovations, there are 11 most popular sectors of innovations in this database. See Figure 10.

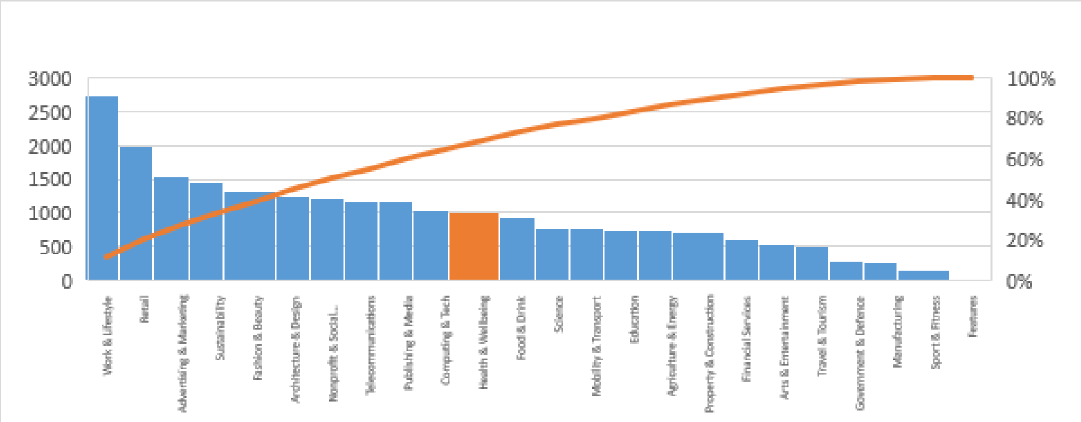

Figure 10. Database entries by sectors.
Source: created by the authors based on Springwise, 2022.

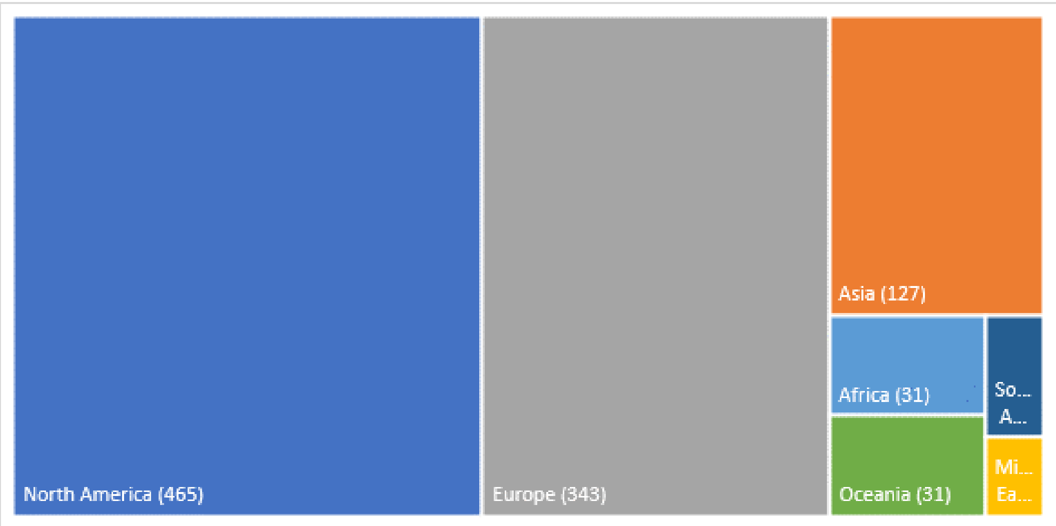

Figure 11. Database entries by countries for health and well-being innovations.
Source: created by the authors based on Springwise, 2022.

To find the cases for the web-based IMS approach another process was selected (see Figure 12), but case study steps are the same as in Table 1.

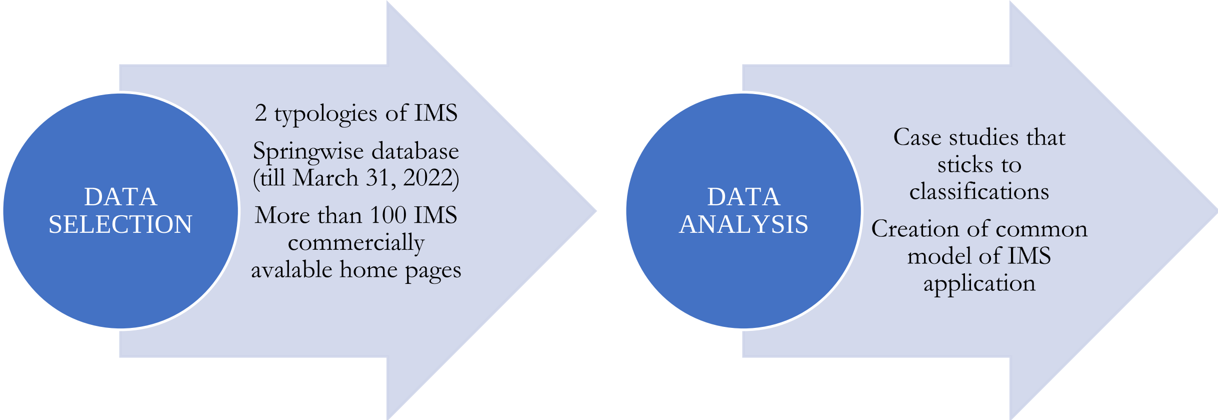

Figure 12. IMS analysis data collection and analysis.
Source: created by the authors.

See Table 3 category map for IMS cases.

Table 3. Category map for case study

	Web-based IMS
Idea management	The purpose of use
Organisation system	A product user
	The size of an organization (large/medium/small according to the EU principles)
	A country (a product user)
	Pre-use experience (yes/no, if so, how long)
	Idea management moderation (automatic, manual, both)
	The ownership of ideas (company, ideas, shared)
	Local or international use
	The number of people involved/the size of network
Other structural sources - task	A task
	Time period
	The method of using the idea management system (internal ideas management, external ideas management, mixed ideas management)
	Parties involved in idea management
	Active (focused)/Liability (unfocused)
	Product/process/organizational/marketing/all ideas created
	Adaptability (whether a task is tailored to different idea management members, one evaluates, while another group creates ideas)
	Award for the Best Ideas (yes/no)
Idea managementdir ect results	The quantity of ideas
	The quality of ideas (how advanced solutions are)
	Engagement (how many people are involved)

Usage types – how the system has been accepted/used	Whether the mode of use is consistent with the type of idea management (consistent/inconsistent)
Final results	Achieving an eligible target (yes/no)
	In the case, those end-gains
Application based on the created classifications	Classifications based on the IM application (based on 9 elements of Business Model Canvas)

Source: Source: developed by the author

4. Results

4.1. Statistical Analysis Results

The following Table 4 summarizes the chi-squared test for changes in online health care demand over the recent years.

Table 4. χ^2- test statistics on online health care dynamic

Question	χ^2- statistic	χ^2- critical	p-value
Online health care information searching 2021 vs 2018	69.08	43.77	<0.001
Online health care services 2021 vs 2020	135.06	38.89	<0.001

Source: developed by the author

Since χ^2- statistic (69.08) is significantly greater than χ^2- critical (43.77) at a confidence level 0.95, we can conclude that changes in search habits for health information during the last three years have been statistically significant and, since χ^2- statistic (135.06) is significantly greater than χ^2- critical (38.89) at confidence level 0.95, we can conclude that changes in online health care services during 2021 were statistically significant. These conclusions are supported by a low p-value (<0.001).

Regression models were calibrated to determine trends in the intensity of digital health care funding and the parameters of which are summarized in Table 5.

Table 5. Digital health care and digital therapeutics funding volumes regression models statistics

Model	Type	R2	Fstat	Fcrit	p-value
Digital health care funding volumes	Polinom	0.8980	17.6090	6.9443	0.0104
Digital therapeutics funding volumes	Polinom	0.9237	24.2034	6.9443	0.0058

Source: developed by the author

Calibrated models are statistically stable because Fstat >> Fcrit and these conclusions are confirmed by low p-values (p <0.011). Thus, we can conclude that the growth of funding volumes in both digital health care and digital therapeutics elevated much faster during pandemic times than before.

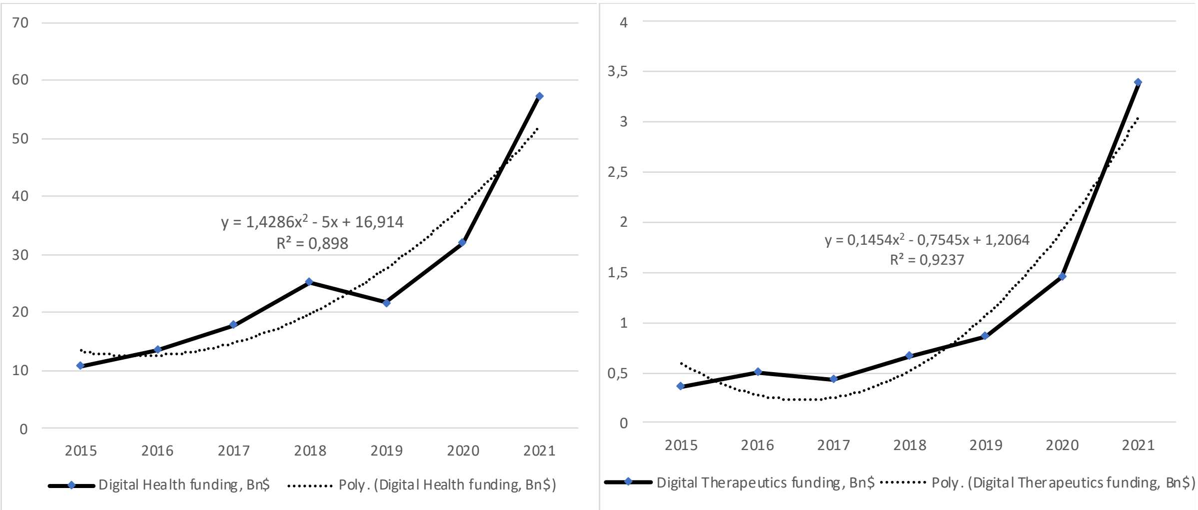

Figure 14. Digital health and digital therapeutics funding volumes trends.
Source: created by the authors based on CB Insights data.

The parameters of calibrated regression models to determine trends in the intensity of digital health care funding by regions are summarized in Table 6.

Table 6. Digital health care funding intensity regional regression models statistics

Model	Type	R2	Ffact	Fcrit	p-value
The US digital health funding deals	Linear	0.8973	43.6962	6.6079	0.0012
Asia digital health funding deals	Linear	0.8360	25.4919	6.6079	0.0039
Europe digital health funding deals	Linear	0.9466	88.5957	6.6079	0.0002
Other regions digital health funding deals	Linear	0.9091	49.9978	6.6079	0.0009

Source: developed by the author.

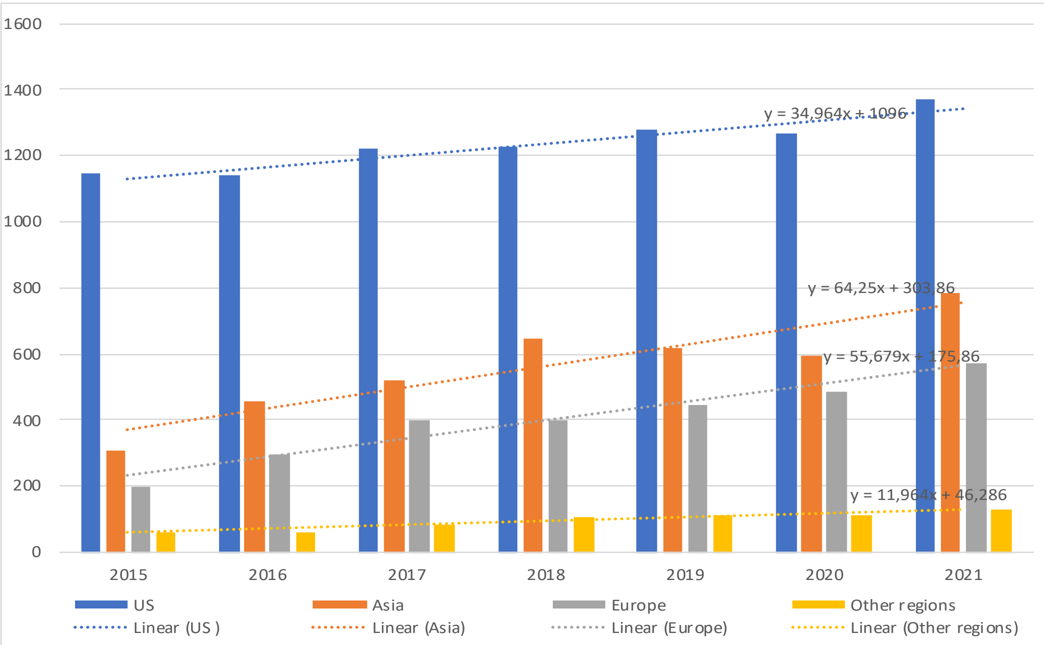

Figure 15. Digital health funding deals by regions trends.
Source: created by the authors based on CB Insights data.

Calibrated models are statistically stable because Fstat >> Fcrit and these conclusions are confirmed by low p-values ($p < 0.01$). Thus, we can conclude that the average annual number of investments in digital health grew by about 35 transactions per year in the USA, by about 64 transactions per year in Asia, by about 56 transactions per year in Europe, and by about 12 transactions per year in other regions.

The parameters of calibrated regression models to determine trends in the volumes of digital health care funding by regions are summarized in the following Table 7.

Table 7. Digital health care funding volumes regional regression models statistics

Model	R2	Ffact	Fcrit	p-value
The US digital health funding volumes	0.7695	16.6937	6.6079	0.0095
Asia digital health funding volumes	0.7400	14.2276	6.6079	0.0130
Europe digital health funding volumes	0.7920	19.0421	6.6079	0.0073
Other regions digital health funding volumes	0.7592	15.7658	6.6079	0.0106

Source: developed by the author.

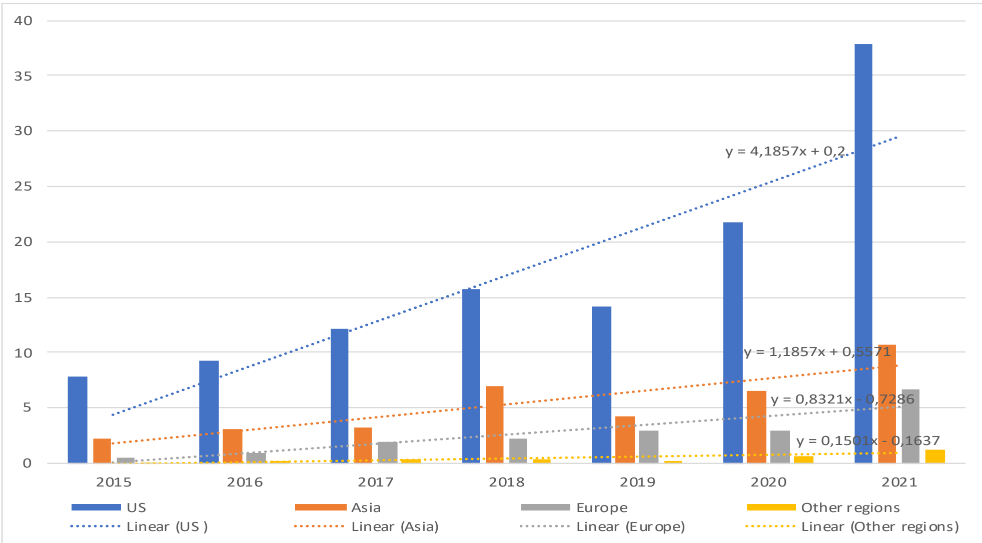

Figure 16. Digital health funding volumes by regions trends.
Source: created by the authors based on CB Insights data.

Calibrated models are statistically stable because Fstat >> Fcrit and these conclusions are confirmed by low p-values (p <0.013). Thus, we can conclude that the average annual volumes of investments in digital health increased by about 4.2 Bn$ per year in the USA, by about 1.2 Bn$ per year in Asia, by about 0.83 Bn$ per year in Europe, and by about 0.15 Bn$ per year in other regions.

4.2. Healthcare Innovations and Idea Management Systems

Springwise databases have summarized 1007 different health and well-being innovations. Based on these data the authors can conclude that the most frequent business models for health innovations are B2C and B2B. And some of them have been applied in the research (119) and 34 have created based on the crowdsourcing paradigm.

Research and crowdsourcing cases were later researched in detail from an IM application type perspective – because their research innovations will be mostly internal IM results, but crowdsourcing will be – external IM result and in some cases mixed IM. So, in these cases also such kind of web-based IMS could be used.

See Figure 17 Technologies that have been created by these health and well-being innovations.

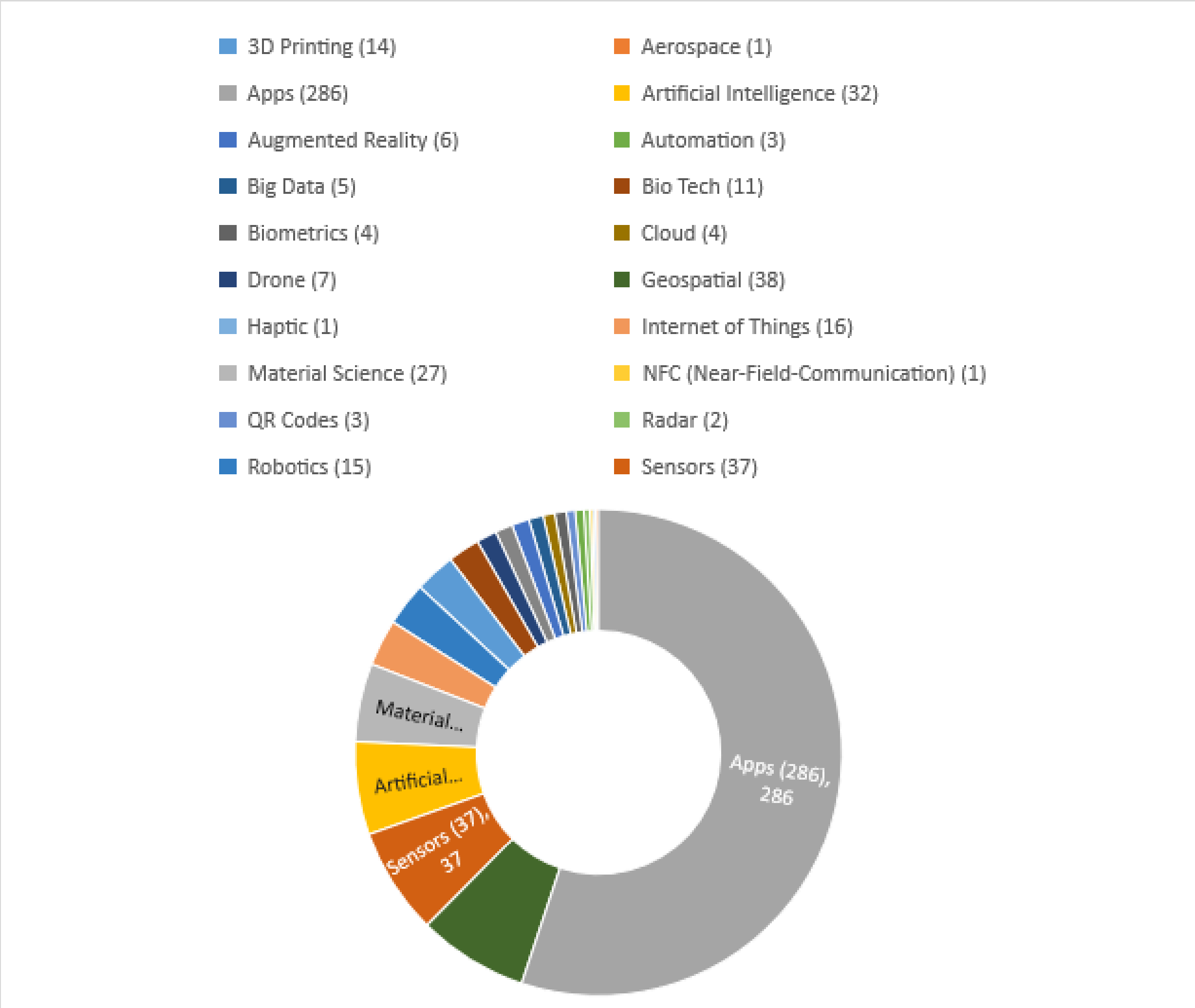

Figure 17. Database entries by technologies.
Source: created by the authors based on Springwise, 2022.

Apps are the most common digital innovation created in health and well-being. More specific technologies that are commonly used are artificial innovations, biotech, the Internet of things, sensors, 3D printing, and material science technologies.

In Figure 18 the authors have described the most common topics that these cases are related to. Coronavirus was one of the main topics for innovations – 191 innovations have been created in relation to this innovation.

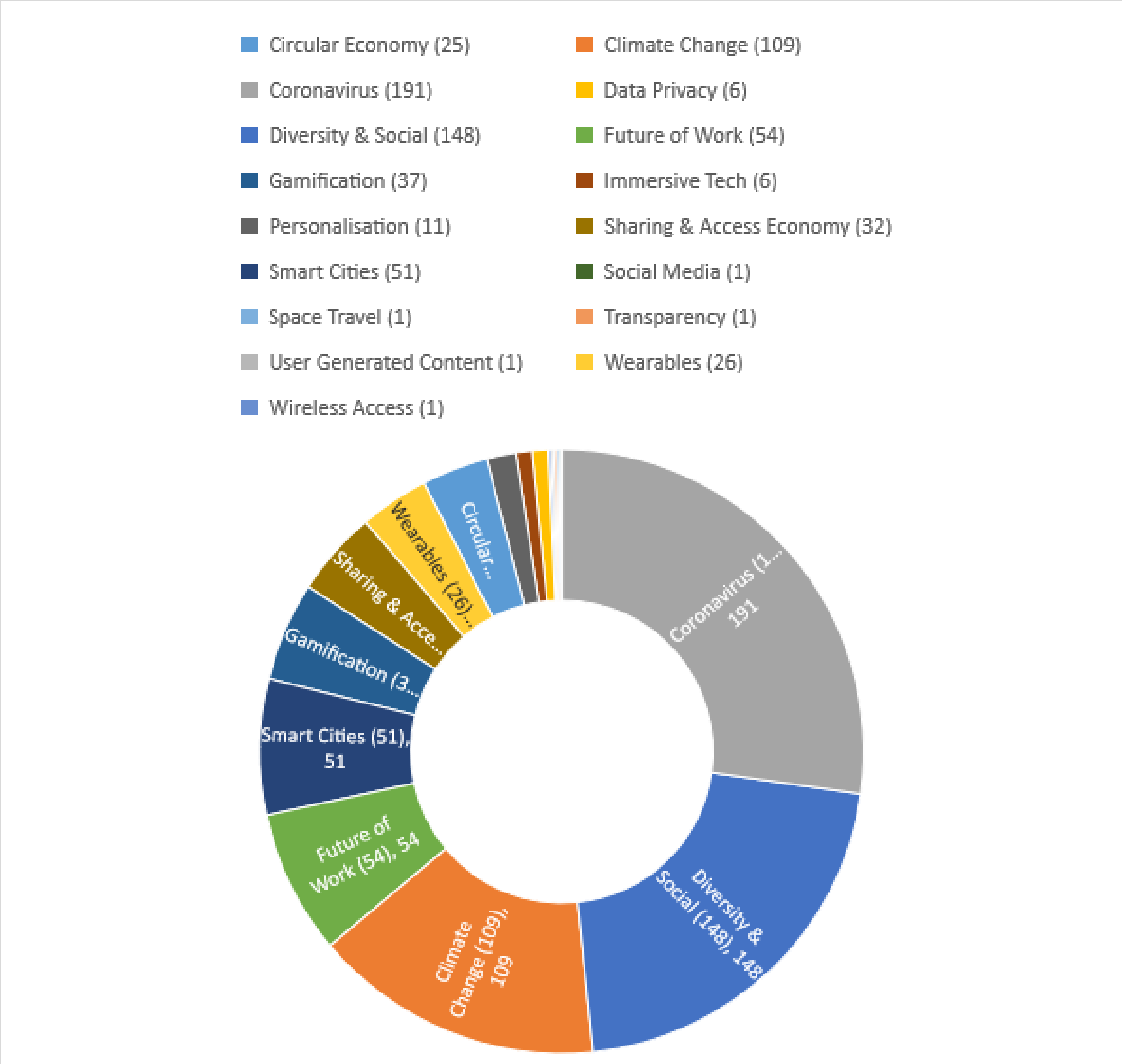

Figure 18. Database entries by topics.
Source: created by the authors based on Springwise, 2022.

It is not possible to characterise in this paper all 1007 healthcare innovations, and even not 191 innovations that took place during coronavirus time period and could be regarded as the main topic. So, the authors have decided to select and describe 5 diverse cases.

The first case is start-up Alike, which has understood that in medicine 'law of average' nowadays is not appropriate - so they have developed a solution – AI that creates matchmaking between patients, so they could share their experiences and provide personalised healthcare insights. See the case map in Table 8.

Table 8. Case study 1

Basic	Alike
	Israel
	2022
	A creator (a private sector)
Innovation description	The problem that the innovation solves: a traditional medicine is based on a 'law of averages' – it is a misleading approach!
	A product user (patients)
	The description of the innovation: 'A multidisciplinary solution to this problem – using health data and machine learning to match people who are alike on a holistic level. The AI's matchmaking takes into account

	considerations such as co-morbidities, lifestyle factors, age, and gender.' To communicate with persons that are in similar situation.
	Innovation type is based on results (a product)
	Closed
Source for citations	https://www.springwise.com/innovation/health-wellbeing/tapping-into-the-power-of-healthcare-records

Source: developed by the authors

Start-up Fornix has created a virtual reality technology that exposes patients to their object of fear in a controlled way and during the development process they have involved diverse crowd-clinical experts, researchers, and university representatives. See the case map in Table 9.

Table 9. Case study 2

Basic	Fornix
	Norway
	2022
	A creator (a private sector and an academic sector)
Innovation description	The problem that the innovation solves: 'one quarter of the global population will suffer from some form of anxiety during their lifetime'.
	A product user (hospitals and specific experts)
	The description of the innovation: 'Virtual Reality Exposure Therapy (VRET). This leverages a virtual reality (VR) technology to expose patients to the object of their fear in a controlled way in the safe space of a therapist's office. At present, Fornix offers programmes for acrophobia (the fear of heights), arachnophobia (the fear of spiders), astraphobia (the fear of thunder and lightning), odontophobia (the fear of dentistry), and trypanophobia (the fear of blood or needles).'
	Innovation type is based on results (a product)
	Open
Source for citations	https://www.springwise.com/innovation/health-tech/mental-heath-care-in-a-virtual-environment

Source: developed by the authors

Table 10 describes the case of BrainCapture at the Technological University of Denmark which has developed a cheap and mobile electroencephalogram equipment dealing with complexity and high prices for alternatives.

Table 10. Case study 3

Basic	BrainCapture
	Denmark
	2022
	A creator (a private sector and an academic sector)
Innovation description	The problem that the innovation solves: 'Although epilepsy can be treated with affordable drugs, diagnosing the disease has typically proven difficult in developing countries due to a lack of specialist equipment and neurologists with the required skills.'
	A product user (hospitals and specific experts)
	The description of the innovation: 'BrainCapture has developed a cheap and mobile electroencephalogram (EEG) equipment which is built using technology developed at the Technological University of Denmark (DTU Compute). The new device consists of a cap of electrodes which is placed on the patient's head.'

	Innovation type is based on results (a product)
	Open
Source for citations	https://www.springwise.com/innovation/health-wellbeing/low-cost-diagnosis-for-epilepsy

Source: developed by the authors

A new browser-based solution Anura provides more than 30 different health measurements by analysing video clips, more about this innovation in Table 11.

Table 11. Case study 4

Basic	Anura
	Canada
	2022
	A creator (a private sector)
Innovation description	The problem that the innovation solves: health and wellness measurement complexity and time consumption.
	A product user (patients)
	The description of the innovation: 'Anura offers over 30 health measurements including heart rate, breathing rate, blood pressure, stress levels, and metabolic risks. The new browser-based version provides the same level of measurement on any device with no download required.'
	Innovation type is based on results (a product)
	Closed
Source for citations	https://www.springwise.com/innovation/health-wellbeing/health-measurements-from-a-video-selfie

Source: developed by the authors

Pollie is the platform which provides people with hormonal imbalance with the support they need (See Table 12).

Table 12. Case study 5

Basic	Pollie
	The USA
	2021
	A creator (a private sector)
Innovation description	The problem that the innovation solves: 'polycystic ovarian syndrome (PCOS), a common painful and stressful condition that is often misdiagnosed and affects about 8 to 13 out of every 100 women. PCOS is also recognised as one of the greatest causes of infertility and increases the risk of developing other cardiovascular. '
	A product user (patients)
	The description of the innovation: 'The platform provides individuals with a personalised programme which includes a dedicated care team of doctors, life coaches and dietitians alongside a variety of lab options and educational content.'
	Innovation type is based on results (a product)
	Closed
Source for citations	https://www.springwise.com/innovation/health-wellbeing/femtech-startup-PCOS-hormone-imbalance-equality

Source: developed by the authors

Though, how to find and develop such kind of innovations in the times when everything is changing so rapidly? The landscape of the healthcare industry has changed drastically over the past few years due to changes in demand and digitalisation. Healthcare and pharmaceutical companies have uncovered the potential of web-based IMS to deal with this problem – externally by crowdsourcing and internally from employees. For example, a web-based IMS Spigit is applied by UnitedHealth Group, Adventis Health, Pfizer, and Cigna (Spigit, 2022). It is an excellent opportunity to involve patients directly in value creation, and also to make an employee involvement in these processes more effective, but it also suggests and gives opportunities to involve other stakeholders in IM to create innovations.

Employees have been engaged in the operating room sustainability and more than 90% of projects for implementation have been slated – these are just a few of the results that have been achieved by Vancouver Coastal Health, which provides healthcare services to 1.25 million people and has more than 18,000 employees. Internal IMS has helped them to use the power of employees in their specialisation areas – a primary care, mental health, public health, home health care, and community-based residential care (IdeaScale, 2022a).

BAYADA Home Health Care provides home health care by applying IdeaScale Bright Idea Forum in their 260 office places. They have gained 100% participation and by that have produced organization-wide changes in the processes and organisation – a crowdsourcing approach (IdeaScale, 2022b).

Also, public sector representatives in healthcare apply these systems, for example, the Food and Drug Administration (4,500 employees) within the Department of Health and Human Services (the USA) – achieved an 80% participation rate from their engaged employees and generated hundreds of ideas that improved internal Center for Drug Evaluation and Research functions (Idea Scale, 2022c).

To summarize the results on web-based IMS application for the creation of digital healthcare innovations. It was summarized that all types of web-based IMS could be used to create and improve these innovations. In Figure 19 is shown the process how different IMS organisations could conduct IM process through an innovation funnel. To collect more ideas, it is important to involve different idea sources, that is, internal, external, and also sometimes to use mixed approaches. After a source selection, organisations should select if they would like to define a specific task (active IMS) or just to collect all ideas (passive IMS).

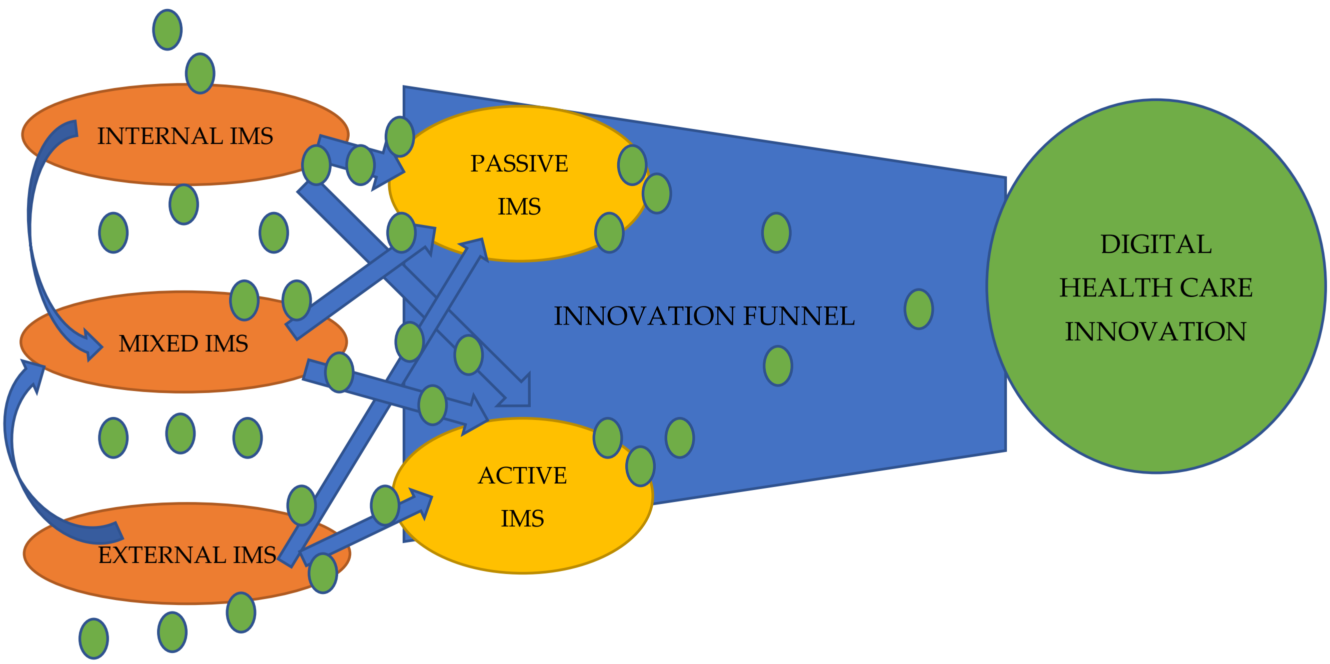

Figure 19. Idea Management System Application to Create Digital Healthcare Innovations.
Source: developed by the authors.

What kind of internal and external IM sources to involve? Based on the cases and innovation descriptions the authors have summarized the information about possible sources in Table 13.

Table 13. Internal, external, and mixed IM sources

INTERNAL IM SOURCE:	**EXTERNAL IM SOURCE:**	
Internal employees Specific departments	University representatives Researchers NGO Society/ crowds Patients Patient Families Mentors	Other organisations/ enterprises Ministries Municipalities Hospitals Experts Technology enthusiasts
MIXED IM SOURCES		

Source: developed by the authors

Web-based IMS IdeaScale (2022) helps a healthcare organisation to find new treatments and technologies and improve overall a patient care by providing an opportunity for collaboration of doctors, patients, researchers, and healthcare institution employees, thus building the future of healthcare. If all these sources are involved, it is an excellently mixed IMS.

The authors see the potential that the proposed web-based IMS application could help in implementation of mission innovations related to health and well-being, for example, in a mission definition web-based IMS could help gathering and evaluating ideas, after that for a selected mission to find possible projects (solutions) and at the end during an implementation support a process by idea management (See Figure 20).

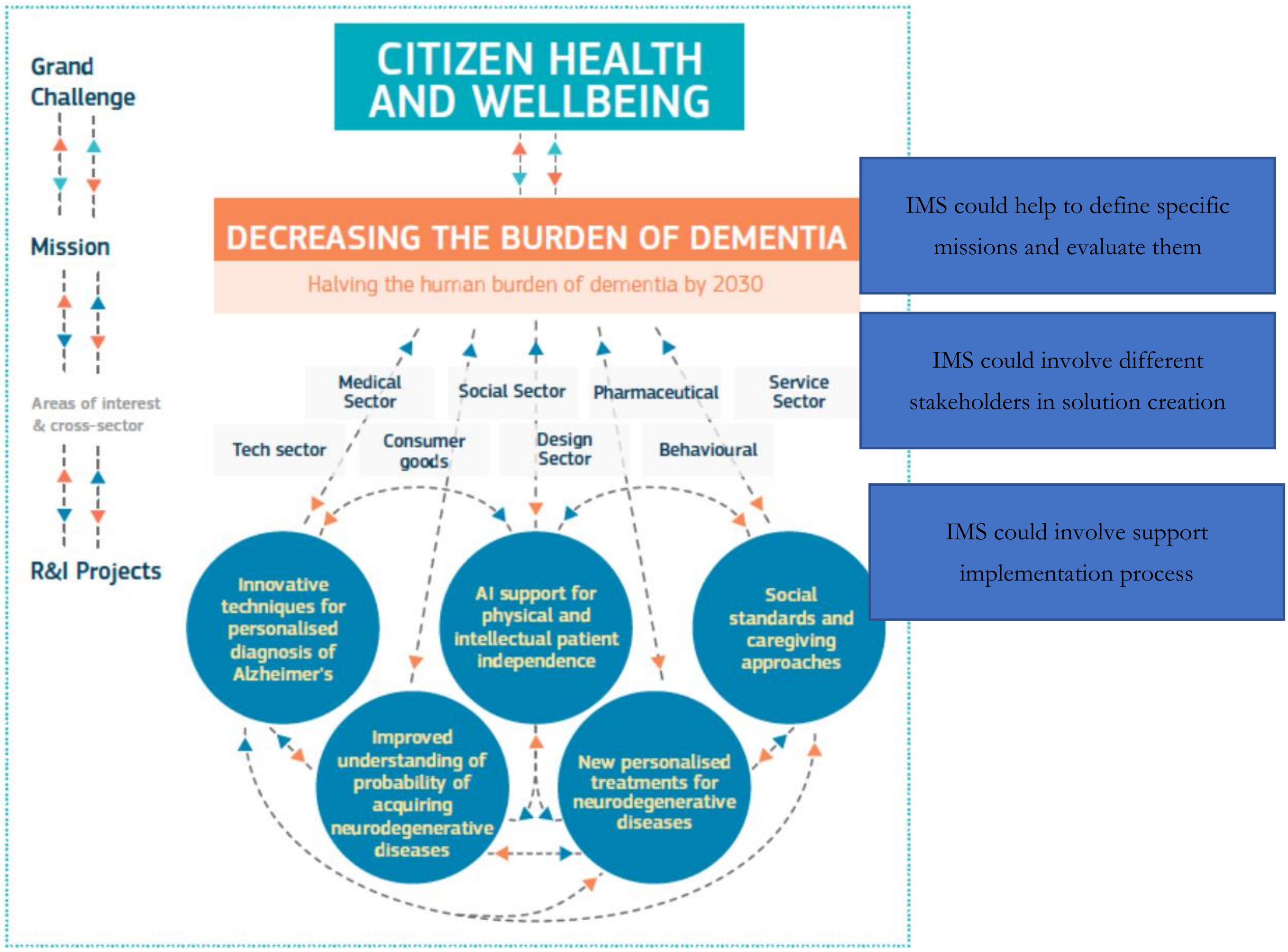

Figure 20. Mission innovations.
Source: Mazzucato, 2018.

5. Conclusions

5.1. Summary

Leading countries in the search for health information online in this field, such as Finland (80%), the Netherlands (77%), Norway (77%), etc. are considerably ahead of Bulgaria (36%) and Romania (40%). At the same time, there has been variant progress over the last three years

In the European Union, telemedicine services were also developing rapidly during a pandemic. Eurofound data shows a different level of development of this service, in countries such as Finland, Slovenia, Poland, Ireland, and Lithuania accounting for more than 50%, while Malta, Germany, and France significantly below 30% (Eurofound, 2021).

The intensity of investments in the United States is significantly higher than in the rest of the world, but the development trend is markedly increasing both in the Asian region and in Europe.

The volumes of attracting digital medicine funding in the United States show a particularly rapid increase during a pandemic - the growth in 2020 compared to 2019 reached 53.9%, but in 2021 compared to 2020 even grew to 74.7%. The Asian region and Europe have also seen a sharp increase in leverage over the past two years, but pre-pandemic levels were significantly lower than in the United States.

Since χ^2- statistic (69.08) is significantly greater than χ^2- critical (43.77) at confidence level 0.95, we can conclude that changes in search habits for health information during the last three years have been statistically significant and, since χ^2- statistic (135.06) is significantly greater than χ^2- critical (38.89) at confidence level 0.95, we can conclude that changes in online health care services during the 2021 were statistically significant. These conclusions are supported by a low p-value (<0.001).

We can conclude that the average annual number of investments in digital health increased by about 176 transactions per year, but the number of investments in digital therapeutics - by 10 transactions on average per year.

The growth of funding volumes in both digital health care and digital therapeutics was increasing much faster during pandemic times than before.

The average annual number of investments in digital health grew by about 35 transactions per year in the USA, by about 64 transactions per year in Asia, by about 56 transactions per year in Europe, and by about 12 transactions per year in other regions.

The average annual volumes of investments in digital health rose by about 4.2 Bn$ per year in the USA, by about 1.2 Bn$ per year in Asia, by about 0.83 Bn$ per year in Europe, and by about 0.15 Bn$ per year in other regions.

Apps are the most common digital innovation created in health and well-being. More specific technologies that are commonly used are artificial innovations, biotech, the Internet of things, sensors, 3D printing, material science technologies. The most common topics that these cases are related to Coronavirus was one of the main topics for innovations – 191 innovations have been created in relation to this innovation.

To collect more ideas, it is important to involve different idea sources, that are, internal, external, and, also sometimes to use mixed IMS approaches. After source selection organisations should be selected if they would like to define a specific task.

5.2. Implications

Academic contribution. The authors of the paper have concentrated their attention on the COVID-19 period that was the time of changes in healthcare and have described the demand changes during that period by answering to the research questions. In this paper, the authors have tried to link it with a web-based idea management system potential. Most common technologies and topics for healthcare innovations have been reviled.

Regression models were calibrated to determine trends in the intensity of digital health care funding and the parameters. The parameters of calibrated regression models to determine trends in the volumes of digital health care funding have been analysed. The parameters of calibrated regression models to determine trends in the intensity of digital health care funding by regions have been researched. The parameters of calibrated regression models to determine trends in the volumes of digital health care funding by regions have been summarized.

Practical contribution. The paper widens the understanding about funding and demand, which could practically help organisations to understand the existing demand and the supply of innovations to create new digital healthcare innovations.

5.3. Future Studies

Future research studies should deal with the limitations of innovation databases analysed - more databases should be included and compared.

At the moment, the research has highlighted overall technology and topic trends in healthcare innovations, but these elements should be researched in detail. Each part could be a separate research, for example, sensors, drones in healthcare or sustainability from a topic perspective.

In the paper, the authors have included only 5 cases but there are more cases, and they should be studied in detail because there is available information that could lead to the more detailed results about the supply of digital healthcare innovations.

There is limited information about web-based IMS applications in the healthcare industry publicly, so future research studies should use different methods to gain more in-depth information.

In the paper, the authors have not included detailed information about a web-based IMS as a potential process innovation in an organisation itself, but the future studies could focus on this aspect what organisational and process innovations these systems could provide.

There is so much happening so fast in this space embracing - Big Data, AI, Machine Learning, Genetics/Genomics and Multi-Omics – together with clinical science and technology and human expertise and motivation. It is rich indeed for exploration and research and especially in terms of choices which will need to be made about resource allocation for future focus and resource allocation.

References

Abasi, S., Yazdani, A., Kiani, S., & Mahmoudzadeh-Sagheb, Z. (2021). Effectiveness of mobile health-based self-management application for posttransplant cares: A systematic review. *Health science reports, 4*(4), e434. https://doi.org/10.1002/hsr2.434

Andersen, K.N., Nielsen, J.A., & Kim, S. (2019). Use, cost, and digital divide in online public health care: lessons from Denmark. *Transforming Government: People, Process and Policy, 13*(2), 197-211. https://doi.org/10.1108/TG-06-2018-0041

Asi, Y.M., & Williams, C. (2018). The role of digital health in making progress toward Sustainable Development Goal (SDG) 3 in conflict-affected populations. *International Journal of Medical Informatics, 114*, 114–120. http://dx.doi.org/10.1016/j.ijmedinf.2017.11.003

Balcombe, L., & De Leo D. (2021). Digital Mental Health Challenges and the Horizon Ahead for Solutions. *JMIR Mental Health, 8*(3), e26811. https://mental.jmir.org/2021/3/e26811

Benedict, M., & Schlieter, H. (2015). Governance guidelines for digital healthcare ecosystems. *Studies in health technology and informatics, 212*, 233–240.

Bennion, M. R., Hardy, G., Moore, R. K., & Millings, A. (2017). E-therapies in England for stress, anxiety or depression: what is being used in the NHS? A survey of mental health services. *BMJ Open, 7*, e014844. http://dx.doi.org/10.1136/bmjopen-2016-014844

Bhavnani, S.P., Parakh, K., Atreja, A., Druz, R., Graham, G.N., Hayek, S. S., Krumholz, H. M., Maddox, T. M., Majmudar, M. D., Rumsfeld, J. S., & Shah, B. R. (2017). 2017 Roadmap for Innovation-ACC Health. Policy Statement on Healthcare Transformation in the Era of Digital Health, Big Data, and Precision Health. *Journal of the American college of cardiology, 70*(21), 2697-2718. https://doi.org/10.1016/j.jacc.2017.10.018

Bygstad, B. & Øvrelid, E. (2020). Architectural alignment of process innovation and digital infrastructure in a high-tech hospital. *European Journal of Information Systems, 29*(3), 220-237, https://doi.org/10.1080/0960085X.2020.1728201

CB Insights (2022). State of Digital Health. Global|2021. https://www.cbinsights.com/research/report

Chae, B. (2019). A general framework for studying the evolution of the digital innovation ecosystem: The case of big data. *International Journal of Information Management, 45*, 83-94. https://doi.org/10.1016/j.ijinfomgt.2018.10.023

Chang, J. E., Lai, A. Y., Gupta, A., Nguyen, A. M., Berry, C. A., & Shelley, D. R. (2021). Rapid Transition to Telehealth and the Digital Divide: Implications for Primary Care Access and Equity in a Post-COVID Era. *The Milbank Quarterly, 99*(2), 340-368. https://doi:10.1111/1468-0009.12509

Cheng, D. R., Coote, A., & South, M. (2021). A digital approach in the rapid response to COVID-19 - Experience of a paediatric institution. *International Journal of Medical Informatics, 149*, 104407. https://doi.org/10.1016/j.ijmedinf.2021.104407

Craig, K. J., Fusco, N., Lindsey, K., Snowdon, J. L., Willis, V. C., Arriaga, Y. E., & Dankwa-Mullan, I. (2020). Rapid review. Identification of digital health intervention in atherosclerotic-related cardiovascular disease populations to address racial, ethnic, and socioeconomic health disparities. *Cardiovascular Digital Health Journal, 1*, 139-148. https://doi.org/10.1016/j.cvdhj.2020.11.001

Cremers-Pijpers, S., van Rossum, C., Dautzenberg, M., Wertheim, H., Tostmann, A., & Hopman, J. (2021). Disinfecting handheld electronic devices with UV-C in a healthcare setting. *Infection Prevention in Practice, 3*, 100133. https://doi.org/10.1016/j.infpip.2021.100133

Crispi, F., Naci, H., Barkauskaite, E., Osipenko, L. & Mossialos, E. (2019). Assessment of Devices, Diagnostics and Digital Technologies: A Review of NICE Medical Technologies Guidance. *Applied Health Economics and Health Policy, 17*, 189–211. https://doi.org/10.1007/s40258-018-0438-y

Curfman, A., McSwain, S. D., Chuo, J., Yeager-McSwain, B., Schinasi, D. A., Marcin, J., Herendeen, N., Chung, S. L, Rheuban, K., & Olson, C. A. (2020). Pediatric Telehealth in the COVID-19 Pandemic Era and Beyond. *Pediatrics, 148*(3). https://doi:10.1542/peds.2020-047795

Ding, E. Y., Svennberg, E., Wurster, C., Duncker, D., Manninger, M., Lubitz, S. A., …McManus, D.D. (2020). Survey of current perspectives on consumer-available digital health devices for detecting atrial fibrillation. *Cardiovascular Digital Health Journal, 1*(1), 21-29. https://doi.org/10.1016/j.cvdhj.2020.06.002

Dykgraaf, S. H., Desborough, J., de Toca, L., Davis, S., Roberts, L., Munindradasa, A., McMillian, A., Kelly, P., & Kidd, M. (2021). A decade's worth of work in a matter of days: The journey to telehealth for the whole population in Australia. *International Journal of Medical Informatics, 151*, 104483. https://doi.org/10.1016/j.ijmedinf.2021.104483

Eurofound. (2021). Living, working and COVID-19 dataset. http://eurofound.link/covid19data

Eurostat. (2022). Individuals using the internet for seeking health-related information. https://ec.europa.eu/eurostat/databrowser/view/TIN00101/default/table

Ford, G., Compton, M., Millett, G., & Tzortzis, A. (2017). The Role of Digital Disruption in Healthcare Service Innovation. In M. Pfannstiel, & C. Rasche (Eds.), *Service Business Model Innovation in Healthcare and Hospital Management.* Cham: Springer.

Gjellebæk, C., Svensson, A., Bjørkquist, C., Fladeby, N., & Grunden, K. (2020). Management challenges for future digitalization of healthcare services. *Futures, 124*, 102636. https://doi.org/10.1016/j.futures.2020.102636

Han, J. K., Al-Khatib, S. M., & Albert, C. M. (2021). Changes in the digital health landscape in cardiac electrophysiology. A pre-and peri-pandemic COVID-19 era survey. *Cardiovascular Digital Health Journal, 2*(1), 55-62. https://doi.org/10.1016/j.cvdhj.2020.12.001

Hospodková, P., Berežná, J., Barták, M., Rogalewicz, V., Severová, L., & Svoboda, R. (2021). Change Management and Digital Innovations in Hospitals of Five European Countries. *Healthcare, 9*, 1508. https://doi.org/10.3390/healthcare9111508

IdeaScale (2022). Healthcare. https://ideascale.com/healthcare/

IdeaScale (2022a). Vancouver Coastal Health. https://ideascale.com/resource/vch/

IdeaScale (2022b). BAYADA. https://ideascale.com/resource/bayada/

IdeaScale (2022c). Food and Drug Administration. https://ideascale.com/resource/food-and-drug-administration/

Iyawa, G. E., Herselman, M., Botha, A. (2017). A Scoping Review of Digital Health Innovation Ecosystems in Developed and Developing Countries. *IST-Africa 2017 Conference Proceedings.* http://hdl.handle.net/10204/9673

Javaid, M., & Khan, I. H. (2021). Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic. *Journal of Oral Biology and Craniofacial Research, 11*, 209-214. https://doi.org/10.1016/j.jobcr.2021.01.015

Keasberry, J., Scott, I.A., Sullivan, C., Staib, A., & Ashby, R. (2017). Going digital- a narrative overview of the clinical and organisational impacts of eHealth technologies in hospital practice. *Australian Health Review, 41*, 646–664. http://dx.doi.org/10.1071/AH16233

Kouroubali, A., Kondylakis, H., & Katehakis, D. G. (2021). Integrated Care in the Era of COVID-19: Turning Vision into Reality With Digital Health. *Frontiers in Digital Health, 3*, 647938. https://doi:10.3389/fdgth.2021.647938

Kraus, S., Schiavone, F., Pluzhnikova, A., & Invernizzi, A. C. (2021). Digital transformation in healthcare. Analyzing the current state of research. *Journal of Business Research, 123*, 557-567. https://doi.org/10.1016/j.jbusres.2020.10.030

Krejci, D., & Missonier, S. (2021). Idea management in a digital world: An adapted framework. Paper presented at the *Proceedings of the Annual Hawaii International Conference on System Sciences* (pp. 5851-5860).

Kuo, A. (2011). Opportunities and challenges of cloud computing to improve health care services. *Journal of Medical Internet Research, 13*(3), e67. doi:10.2196/jmir.1867

Kursīte, M., Stars, I., Strēle, I., Gobiņa, I., Ķīvīte-Urtāne, A., Behmane, D., Dūdele, A., & Villeruša, A. (2022). A mixed-method study on the provision of remote consultations for non-communicable disease patients during the first wave of the COVID-19 pandemic in Latvia: lessons for the future. *BMC health services research, 22*(1), 263. https://doi.org/10.1186/s12913-022-07634-x

Lai, L., Sato, R., Ouchi, K., Landman, A. B., & Zhang, H. M. (2021). Digital health innovation to integrate palliative care during the COVID-19 pandemic. *American Journal of Emergency Medicine, 46*, 664-666. https://doi.org/10.1016/j.ajem.2020.08.008

Laurenza, E., Quintano, M., Schiavone, F., & Vrontis, D. (2018). The effect of digital technologies adoption in healthcare industry: a case-based analysis. *Business Process Management Journal, 24*(5), 1124-1144. https://doi.org/10.1108/BPMJ-04-2017-0084

Lee, D., & Yoon, S. N. (2021). Application of Artificial Intelligence-Based Technologies in the Healthcare Industry: Opportunities and Challenges. *International Journal of Environmental Research and Public Health, 18*(1), 271. http://dx.doi.org/10.3390/ijerph18010271

Lee, S. M., & Lee, D. H. (2021). Opportunities and challenges for contactless healthcare services in the post-COVID-19 Era. *Technological Forecasting & Social Change, 167*, 120712. https://doi.org/10.1016/j.techfore.2021.120712

Mazzucato, M. (2018). Mission-Oriented Research & Innovation in the European Union: A problem-solving approach to fuel innovation-led growth. https://ec.europa.eu/info/sites/default/files/mazzucato_report_2018.pdf

Mikelsone, E., Spilbergs, A., Segers, J.-P., Volkova, T., & Liela, E. (2022). Better Ideation Task Results in Web-Based Idea Management Systems. *Businesses, 2*(2), 129-140. https://doi.org/10.3390/businesses2020009

Mikelsone, E., & Segers J. P. (2022). Idea Management Canvas: Big Picture of Web-based Idea Management Models. Business: Theory and Practice, 23(2), 485–501. https://doi.org/10.3846/btp.2022.16916

Mikelsone, E., Spilbergs, A., Volkova, T. & Liela, E. (2021). Ideas Management: From a Management Perspective. World Scientific Book Chapters. In P. de Sá Freire, S. Hawamdeh & G. Aparecida Dandolini (ed.), *Knowledge Governance and Learning for Organizational Creativity and Transformation* (pp. 191-212). World Scientific Publishing Co. Pte. Ltd.

Miķelsone, E., Volkova, T. & Lielā, E. (2019). Practical Evidence of Web-Based Idea Management Systems: Classification and Application. *Proceedings of the 25th International Scientific Conference "Research for Rural Development 2019"* (pp. 268-275). Latvia University of Life Sciences and Technologies, 15th-17th May 2019, Jelgava. doi: 10.22616/rrd.25.2019.080

Mishra, S., & Tripathi, A. R. (2021). AI business model: an integrative business approach. *Journal of Innovation and Entrepreneur-ship,10*, article 18. https://doi.org/10.1186/s13731-021-00157-5

Nikou, S., Agahari, W., Keijzer-Broers, W., & de Reuver, M. (2020). Digital healthcare technology adoption by elderly people: A capability approach model. *Telematics and Informatics, 53*, 101315. https://doi.org/10.1016/j.tele.2019.101315

Nimmagadda, S. L., Reiners, T., Wood, L. C., & Chitti, S. K. (2019). On Modelling Digital Healthcare Ecosystems and their Knowledge Management. In *25th Americas Conference on Information Systems* (pp. 15-17). http://hdl.handle.net/20.500.11937/81148

Oborn, E., Pilosof, N. P., Hinings, B., & Zimlichman, E. (2021). Institutional logics and innovation in times of crisis. Telemedicine as digital 'PPE'. *Information and Organization, 31*, 100340. https://doi.org/10.1016/j.infoandorg.2021.100340

Oderanti, F. O., Li, F., Cubric, M., & Shi, X. (2021). Business models for sustainable commercialisation of digital healthcare (eHealth) innovations for an increasingly ageing population. *Technological Forecasting & Social Change, 171*, 120969. https://doi.org/10.1016/j.techfore.2021.120969

OECD (2021). ICT Access and Usage by Households and Individuals. Individuals using the Internet for seeking health information. https://stats.oecd.org/Index.aspx?DataSetCode=ICT_HH2

Pappas, I. O., Mikalef, P., Giannakos, M. N., Krogstie, J., & Lekakos, G. (2018). Big data and business analytics ecosystems: paving the way towards digital transformation and sustainable societies. *Information Systems and e-Business Management, 16*, 479–491 (2018). https://doi.org/10.1007/s10257-018-0377-z

Petrakaki, D., Hilberg, E., & Waring, J. (2021). The Cultivation of Digital Health Citizenship. *Social Science&Medicine, 270*, 113675. https://doi.org/10.1016/j.socscimed.2021.113675

Porter, M. E., & Kramer, R. M., (2019). Creating shared value. *Managing Sustainable Business* (pp. 323-346). Springer.

Raghupathi, W., & Kesh, S. (2009). Designing electronic health records versus total digital health systems: A systemic analysis. *Systems Research and Behavioral Science, 26*(1), 63-79. http://doi.10.1002/sres.918

Ramadi, K. B., & Srinivasan, S. S. (2021). Pre-emptive Innovation Infrastructure for Medical Emergencies- Accelerating Healthcare Innovation in the Wake of a Global Pandemic. *Frontiers in Digital Health, 3*, 648520. https://doi.org/10.3389/fdgth.2021.648520

Regan, B., Pusatli, O. T., Lutton, E., & Athauda, D. R. (2009). Securing an EHR in a health sector digital ecosystem. 3rd IEEE International Conference on Digital Ecosystems and Technologies. 3rd *IEEE International Conference on Digital Ecosystems and Technologies*. doi:10.1109/DEST.2009.5276739

Reis, J., Amorim, M., Melão, N. & Matos, P. (2018). Digital Transformation: A Literature Review and Guidelines for Future Research. In Rocha Á., Adeli H., Reis L.P., Costanzo S. (eds) *Trends and Advances in Information Systems and Technologies*. WorldCIST'18 2018. Advances in Intelligent Systems and Computing, vol 745. Springer, Cham. https://doi.org/10.1007/978-3-319-77703-0_41

Ricciardi, W., Barros, P.P., Bourek, A., Brouwer, W., Klesey, T., & Lehtonen, L. (2019). How to govern the digital transformation of health services. *European Journal of Public Health, 29*(3), 7–12. doi:10.1093/eurpub/ckz165

S3 Connected Health (2020). Pharma's path to market for digital health solutions: navigating the commercial, data, and regulatory challenges. White paper. Reuters Events Pharma. Pharmas-path-to-market-for-digital-health-solutions-whitepaper.pdf (hubspotusercontent40.net)

Safi, S., Thiessen, T., & Schmailzl, K.J. (2018). Acceptance and Resistance of New Digital Technologies in Medicine: Qualitative Study. *JMIR Research Protocols, 7*(12), e11072. http://doi:10.2196/11072

Schallmo, D. R. A., & Williams, C. A. (2018). *Digital transformation now! - Guiding the successful digitalization of your business model.* Cham: Springer Briefs in Business.

Segers, J.P., & Gaile-Sarkane, E., (2021). Big Pharma's Search for a COVID-19 Vaccine: Take It To The Limit! - Letter from Academia. *Journal of Innovation Management, 9*(2), I-VII. https://doi.org/10.24840/2183-0606_009.002_0001

Segers, J.P., Franco, D., & Mikelsone, E. (2021). Ecologies of Biopharmaceutical Business Models and Aspects of Sustainability. In *Book of Abstracts of the Scientific Conference on Economics and Entrepreneurship*. RTU Press: Riga, Latvia.

Serbanati, L. D., Ricci, F. L., Mercurio, G., Vasilateanu, A. (2011). Steps towards a digital health ecosystem. *Journal of Biomedical Informatics, 44* (4), 621-636, http://doi:10.1016/j.jbi.2011.02.011

Socha-Dietrich, K. (2021). Empowering the health workforce to make the most of the digital revolution. OECD Health Working Papers No. 129. https://doi.org/10.1787/37ff0eaa-en

Spigit (2022). The #1 Innovation Software for Healthcare and Pharmaceuticals. https://www.planview.com/products-solutions/products/spigit/use-case-healthcare-pharmaceuticals/

Springwise (2022). Innovation that matters. https://www.springwise.com/

Stephanie, L., & Sharma, R. S. (2021). Digital health eco-systems: An epochal review of practice-oriented research. *International Journal of Information Management, 53*, 102032. https://doi.org/10.1016/j.ijinfomgt.2019.10.017

Vanhaverbeke, W. (2020). LinkedIn Blog Posts. https://www.linkedin.com/pulse/repurposing-innovation-policies-accelerated-regulated-vanhaverbeke/?trackingId=kBj5KACD3xVy7fP6Z7yc%2FQ%3D%3D

Visconti, R., & Morea, D. (2020). Healthcare Digitalization and Pay-For-Performance Incentives in Smart Hospital Project Financing. *International Journal of Environmental Research and Public Health, 17*(7), 2318. http://dx.doi.org/10.3390/ijerph17072318

Walsh, M. N, Rumsfeld, J. S. (2017). Leading the Digital Transformation of Healthcare. The ACC Innovation Strategy. *Journal of the American College of Cardiology, 70*(21), 2719-2722. https://doi.org/10.1016/j.jacc.2017.10.020