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INNOVATION ECOSYSTEM SUCCESS FACTORS: SUGGESTIONS FOR FURTHER DEVELOPMENT OF CLEVERHEALTH NETWORK - AN INNOVATION ECOSYSTEM OF HEALTH AND WELLBEING TECHNOLOGY

Master's Thesis

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INNOVATSIOONI ÖKOSÜSTEEMIDE EDUTEGURID: ARENGUMUUTUSTE SOOVITUSED TERVISHOIU- JA HEAOLUTEHNOLOOGIA INNOVATSIOONI ÖKOSÜSTEEMILE CLEVERHEALTH NETWORK

Magistritöö

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Tallinn 2019

Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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20.5.2019

Abstract

The focus of this thesis is to study which are the most critical success factors when developing and maintaining an innovation ecosystem. This thesis is an assignment for CleverHealth Network which is a health and wellbeing technology innovation ecosystem in Finland. CleverHealth Network was established in 2017 and is coordinated by Helsinki University Hospital (HUS).

The study will be carried out by conducting a literature overview in order to identify the success factors. The data from existing innovation ecosystems will be collected by using semi-structured thematic interviews. Sample size of the study is four innovation ecosystem members (n=4), two from health and wellbeing technology innovation ecosystems abroad (Welfare Tech and Prime Health) and two from Finnish innovation ecosystems (LuxTurrim5G and One Sea). The interviews will be analysed using affinity diagram method in order to sort all the findings in categories. The academic literature will be compared to the results received from semi-structured thematic interviews.

The results of this thesis will be used when planning development needs of CleverHealth Network. The author of this thesis will introduce the most critical success factors which should be taken in to account in the planning process. The suggestions include fostering interactions inside and outside the ecosystem by arranging more events where all the stakeholders can meet each other. The author suggests also to set up working committees to tackle important issues regarding health care and wellbeing technology field, such as GDPR and other regulations. In addition, partners from other fields with special skills from different technologies for instance, should be acquired to the ecosystem.

This thesis is written in English and is 73 pages long, including 5 chapters, 9 figures and 3 tables.

Annotatsioon
Innovatsiooni Ökosüsteemide Edutegurid: Arengumuutuste Soovitused Tervishoiu- ja Heaolutehnoloogia Innovatsiooni Ökosüsteemile CleverHealth Network

Käesoleva töö eesmärgiks on uurida, millised on olulisimad edutegurid innovatsiooni ökosüsteemide arendamisel ja säilitamisel. Antud magistritöö on valminud Soome tervishoiu- ja heaolutehnoloogia innovatsiooni ökosüsteemi CleverHealth tellimusel. CleverHealth Network loodi 2017. aastal ning seda koordineerib Helsingi Ülikooli Haigla (HUS).

Uuringu läbiviimiseks teostatakse kirjanduse ülevaade eesmärgiga teha kindlaks olulisimad edukuse tegurid. Poolstruktureeritud temaatiliste intervjuude abil kogutakse andmeid olemasolevate innovatsiooni ökosüsteemide kohta ning tulemuste kategoriseerimiseks analüüsitakse intervjuusid afiinsusskeemi meetodil. Uuringu valimimaht on neli innovatsiooni ökosüsteemi liiget, millest kaks on tervishoiu- ja heaolutehnoloogia innovatsiooni ökosüsteemi (*Welfare Tech* ja *Prime Health*) ning kaks Soome innovatsiooni ökosüsteemi (*LuxTurrim5G* ja *One Sea*). Teaduskirjandust võrreldakse poolstruktureeritud temaatiliste intervjuude tulemustega.

Antud töö tulemusi kasutatakse CleverHealth Networki arenguvajaduste planeerimisel. Töö autor tutvustab kõige olulisemaid edutegureid, mida ettevõtte planeerimisprotsessis arvesse võtta. Soovituste hulka kuulub muuhulgas ka ökosüsteemis ja sellest väljaspool toimuva suhtluse edendamine. Seda saab teostada läbi ürituste korraldamise, kus kõik sidusrühmad omavahel kohtuda saavad. Samuti soovitab töö autor moodustada töörühmasid, mis tegeleksid tervishoiu- ja heaolutehnoloogia valdkonna oluliste küsimustega (nt GDPR jm regulatsionid). Lisaks tuleks ökosüsteemi tuua partnereid teistest valdkondadest, kellel on eri tehnoloogiate erioskused.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 73 leheküljel, 5 peatükki, 9 joonist, 3 tabelit.

List of abbreviations

HUS	*Helsinki University Hospital*
CHN	*CleverHealth Network*
IPR	*Intellectual Property Rights*
R&D	*Research and Development*
SME	*Small and Medium-Sized Enterprise*
RTO	*Research and Technology Organization*
IoT	*Internet of Things*
WHO	*World Health Organization*
AI	*Artificial Intelligence*
FDA	*Federal Drug Administration*
MDD	*Medical Device Directive*
GDPR	*General Data Protection Regulation*

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Introduction

Innovation ecosystems are a valuable way for companies to create new innovative solutions together with other partners. Innovation ecosystems brings new ways of thinking and new viewpoints in to the innovation process. Therefore, new ideas from outside makes the innovation process more beneficial for all participating organizations in the ecosystem. [24] It is believed that when companies practice co-opetitive behavior many benefits are achieved such as new knowledge, advantages of external resources and competencies and reduction of costs and risks as they are shared together with the ecosystem actors. [45]

Health and Wellbeing sector is facing major changes when digitalization takes place in the daily activities. Often the demand for a new solution comes from health care professionals however often health care organizations does not have capabilities to develop the new solutions themselves. Therefore, health care providers need co-operation with first of all technology companies as well as with other relevant stakeholders who has the expertise to enable new innovative solutions. Many fields of expertise have innovation ecosystems where the partners co-create together. It is also believed that firms who are part of strong clusters tend to grow faster than firms who are not. [50]

Helsinki University Hospital (HUS), together with partner companies have established an innovation ecosystem, which is orchestrated by HUS and funded by the Finnish funding agency, Business Finland. The ecosystem brings together clinical experts and researchers of HUS, health technology expertise from large corporations and SMEs and HUS's health data storage solution (DataLake). The aim of the ecosystem is to create product and service innovations in the field of health and wellbeing technology by which improving efficiency and patients care. The ecosystem targets also to increase technology exports and to attract foreign investment to Finland.

The aim of this master's thesis is to study existing health care and wellbeing technology innovation ecosystems globally and existing well-functioning innovation ecosystems in Finland. Based on the academic literature and the interviews the results will be compared and identified which success factors remain constant from country to another and from innovation ecosystem to another. As a result, a suggestion for development needs is provided to CleverHealth Network innovation ecosystem.

One main research question (RQ1) and four sub-questions are proposed:

RQ1	What are the critical success factors when developing and maintaining a health and wellbeing technology innovation ecosystem?
	RQ1.1: What are the success factors for innovation ecosystems based on relevant literature? RQ1.2: Which factors are most important for the interviewed innovation ecosystems? RQ1.3: Which success factors remain constant from one country to another when comparing a health technology innovation ecosystem abroad to an innovation ecosystem in Finland? RQ1.4: Are there distinct disparities or similarities between health care technology and non-health care technology innovation ecosystems?

Table 1: The main research question and four sub-questions. Source: Author.

1 BACKGROUND

The delivery of health care is changing due to various reasons. First of all, diseases are increasing, people live longer, and the population is growing. Technology is developing fast which means digitalization captures the health care sector, bringing both opportunities and challenges. The theoretical background of this thesis consists of three dimensions; ecosystems, innovation and health and wellbeing technology.

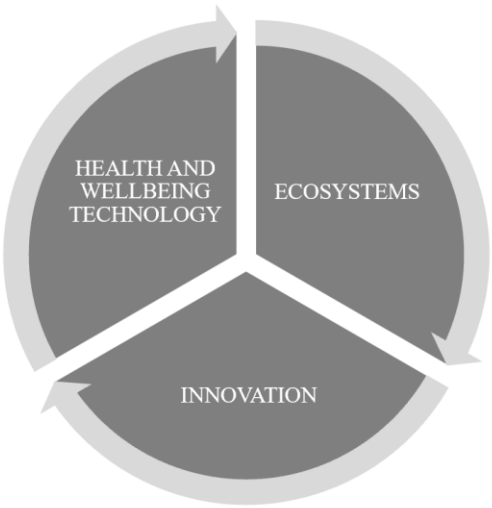

Figure 1: Theoretical framework of the thesis Source: Author.

Ecosystems are described to form a common understanding of what the ecosystem term means and how it is used in the scientific literature. Ecosystems are often divided in types and three of them will be described in the ecosystems chapter; business ecosystem, knowledge ecosystem and innovation ecosystem. When discussing about innovation it is important to know how the other company perceives the term innovation, what does it mean and how is it implemented in the company. Finally, the background chapter introduces health and wellbeing technology as CleverHealth Network innovation ecosystem functions in this field and it is important to understand the different aspects of it.

1.1 Ecosystems

This chapter address the definition of ecosystem and critical examination in terms of using the term ecosystem in the innovation context. The chapter introduces also innovation, knowledge and business ecosystems and discuss the main differences between them. First, a distinction between networks, clusters and ecosystems are introduced.

1.1.1 From Networks and Clusters to Ecosystems

In the ecosystem context the use of terms cluster and network can't be avoided. Also, different definitions and applications for them can be found. In 1998 Porter described clusters to be defined on its geographical area and connections with companies, suppliers, service providers and institutions. [1] Few years later, in 2000, Porter extended the description to include also local institutions to provide support and qualified workforce and competition. [2]

The ecosystem approach differs from the earlier innovation policy in a sense that it does not divide the industries from each other. The ecosystem approach aims to build up new innovations without any industry boundaries. When clusters and networks often are geographically concentrated. Ecosystems are seen more autonomous and more compact than networks and clusters. Ecosystems have ability to evolve independently and spontaneously. [3]

According to D.-S. Oh et al. innovation ecosystems differ from innovation systems, innovation clusters and science centers in the sense that ecosystems has more systemic nature. The term ecosystem emphasizes that ecosystem members have more diversity and more interaction with each other than cluster members. Also, digitalization and the use of open innovation plays an important role in the ecosystem context compared for instance to innovation systems. [3]

The ecosystem structure strives to diversity meaning that when some actor exits the ecosystem some other actor can replace the missing actors' activities. Both networks and ecosystems are founded on dense collaboration which creates value for the

ecosystem actors. A difference between a network and an ecosystem is that ecosystem actors have a common objective which is why a single actors decision affect the operation of the whole ecosystem. While in a network all actors functions individually and pursues their own interests. The ecosystem concept is wide and covers a larger entity of actors whereas a network can consist only of two actors which can then be part of a larger ecosystem. [3]

1.1.2 The Definition of Ecosystem Concept

The term ecosystem originates from the ecology but has started to appear frequently in economy related literature as well. The term “eco” means living organisms and their relation in the environment. “System” has its roots in Greek and means an “organized body”. The term ecosystem can be defined as a set of organisms which are interacting with one another. [4] In a biological ecosystem living species are the base of the ecosystem but without non-living components, such as water or temperature, the ecosystem would not function properly. The inorganic environment provides the habitat for the living species and enables the species diversity when it is in balance. Moore introduced an analogy between biological and business ecosystem concept in which these same conditions prevail. [5]

Moore describes an ecosystem in the business world as a group of participating companies, organizations and individuals who interact and jointly create value to the customer. Ecosystem is often seen as an organized group which evolve over time to the direction which is set usually by the central companies. [5] The use of ecosystem concept started to rise in the business world to visualise the self-organising features from the biological ecosystems. [14] According to Linton it is important, when talking about innovation, to pay attention to the use of terms and in which context to use them. It is important to use the terms in the right contexts and ensure that all parties understand the term in the same way and that they look at the context from the same perspective. This analogy can be applied in the ecosystem context as well. [6] Academic literature shows that the prefix “eco” does not give added value to the context of innovation ecosystems. The ecosystem concept requires further research and a clear definition of the use of the term. [9]

An ecosystem needs an operational model and a shared vision, therefore some formal and informal agreements between ecosystem actors are needed. Based on this fact man-

made ecosystems can't be entirely self-organised even though the government's role is imperceptible in the daily activities of an ecosystem. According also to Papaioannou ecosystems in the business context are not seen as emerging units because they are man-made artificial networks. That is why literature has criticized whether the term ecosystem can really be used to talk about innovation systems. Artificial ecosystems differ from natural ecosystems, at least in their intent and purpose, as well as in the need of government unlike biological ecosystems. [7] Man-made ecosystems are designed and target-oriented systems. The different actors in the ecosystem have different types of objectives for their participation. The public sector is seeking to create new jobs, exports and local quality of life through increased innovation. The private sector is striving for a more efficient value chain and more successful returns.[9]

Valkokari has studied ecosystem types and their relation to each other and points out that every actor in an ecosystem has their own unique perspective because of their own role in the ecosystem therefore the different ecosystem types usually appear bundled together. An ecosystem needs different actors to keep the system in balance and if one actor will be removed a chain reaction to the entire ecosystem can occur. The targeted state of a biological ecosystem is balance; however, it is not always the most optimal state for all the species in the ecosystem. This paradigm could also be adapted in the man-made ecosystems. [8]

1.1.3 Ecosystem Structure

The structure in an ecosystem is often defined through the triple helix thinking where the key partners are academia, industry and government. In the triple helix model academia operates in the knowledge sector and brings the know-how, industry commercializes this know-how and government enables the innovation environment. Nevertheless, from ecosystem perspective other actors such as other research organizations and citizens or consumers are also important stakeholders in the innovation process. [10]

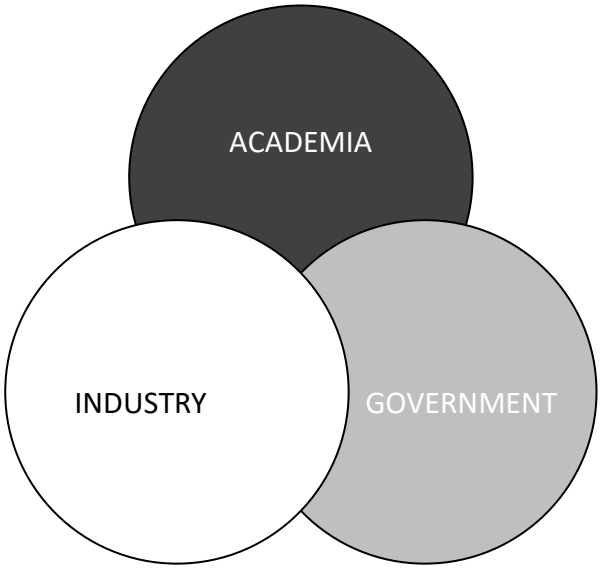

Figure 2: Triple Helix model [10]

Ecosystems can be defined in several ways according to system boundaries; geographical, temporal scale, permeability (open or closed) or types of flows. To be able to understand how the ecosystems functions it is important to define these system boundaries. [11] The type of flow approach is often used in the literature when discussing about ecosystems as it well defines the common purpose of co-operation. Different type of flows can be for instance knowledge, value or material. [8]

All ecosystems are unique in their own way as they always consist of a unique set of actors. This leads in to an independent development. In all kinds of ecosystems, whether it is a man-made or natural, all actors have their own place and task. One actor can also be part of several different ecosystems and have different roles within them. [8] Even though all ecosystems have their own characteristics they still have some common generally recognizable features such as interactivity, self-guidance, interdependence as well as continuous adaptation to changes in the environment. The term ecosystem reminds of the fact that everything is connected to each other within the ecosystem and all the made input flows back to the ecosystem itself, not to some external coordinating party. Interdependence is a dominant feature in the ecosystem however it does not mean that actors are always or all the time in a direct collaboration relationship. [7]

The ecosystem value chain is multifaceted as it consists of the basic value chain added with other relevant stakeholders. The value chain consists of the basic actors; the focal

firm, its suppliers and customers and additionally of universities, public research institutions, governmental organizations, individuals, entrepreneurial teams and other essential organizations. [12]-[17] Focal firm means a keystone player in the ecosystem who often do not have capabilities and resources to create complementary services/products solitary which thrives them to collaborate with other actors. [17] Focal firms are those who create value to the ecosystem by increasing the productivity with connections to other ecosystem participants, but they also provide their own resources in use. [18]

In an ecosystem three different levels of interaction occur; core business, enlarged enterprise and ecosystem. Core business includes direct suppliers, core competencies and different channels of distribution. The level of enlarged enterprise entails the suppliers of suppliers, direct customers and their customers, and suppliers of supplementary products/services. The ecosystem level comprises competitors, co-operators, governments, universities, investors and other stakeholders. [18]

1.1.4 Ecosystem types

Weber and Hine define ecosystems as structures and relationships between the actors in the ecosystem. A well-functioning ecosystem should always be more than the sum of its actors. [19] Valkokari introduces three different ecosystem types; business ecosystem, knowledge ecosystem and innovation ecosystem. These three concepts seem to appear most frequently in the ecosystem literature. Valkokari discuss the linkages and divergence between these three ecosystems in her studies. This study concentrates on the innovation ecosystem approach however the differences between these three ecosystems will be discussed as it is important to understand that one actor can act in all of them performing different tasks. [8]

Business ecosystems concentrates on value creation regarding economic outcomes and on building business relationships. Whereas innovation ecosystems focus on innovation creation. In knowledge ecosystems the main outcome is new knowledge which is achieved through joint research and collaboration. [8]

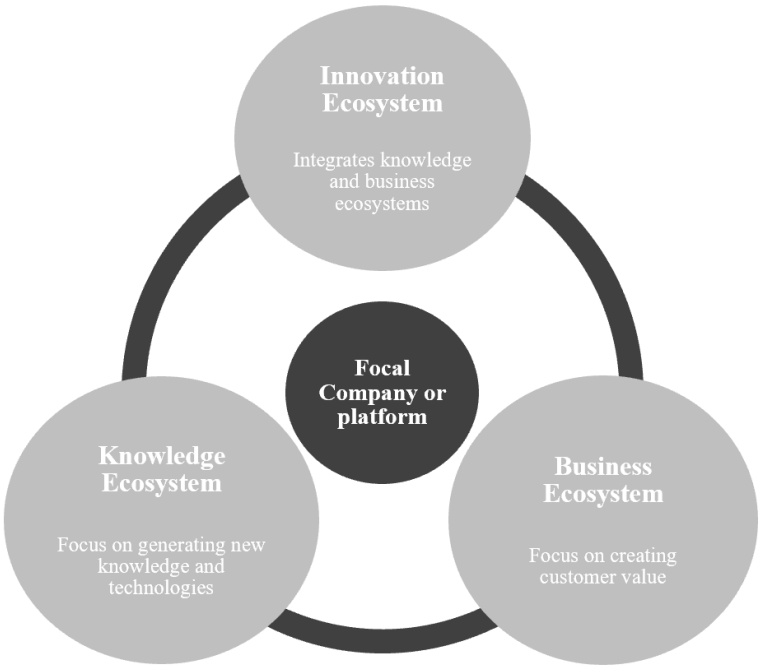

Figure 3: The disparities of Innovation, Business and Knowledge ecosystems by Valkokari. [8]

Clarysse et al. have studied knowledge and business ecosystems and found three main differences between them; ecosystem activities, connectivity among ecosystem partners and keystone player. [15] The main purpose of a knowledge ecosystem is to gain knowledge and maintain tight collaboration between ecosystem partners therefore they are often geographically localized. [20] The key activities are centralized in the university and networking with the key companies around. Based on Clarysse et al. a member of a knowledge ecosystem does not automatically become a member of a business ecosystem, where the solution will be commercialised. Although knowledge and business ecosystems are not mutually exclusive.[15]

Clarysse et al., Gawer and Wright have pointed out one main difference between business and innovation ecosystems; innovation ecosystems lack on the demand side. Business ecosystems approach the customer in more tangible way whereas in innovation ecosystems the customer is often taken for granted. [15] [21]

Adner has studied innovation ecosystems and defines them as follows “the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution”. [24] Innovation ecosystems should create value which no

single company could make alone. According to Durst and Poutanen, successful implementation of ecosystems requires balance between governance, strategy and leadership, organizational culture, resources, human resources management, people, partners, technology and clustering. [9]

Wessner describes innovation ecosystems as systems where the output has more value than the inputs together. These synergies are captured in the work where the ecosystem participants work together for a joint goal. A well-functioning ecosystem unite different institutions through interactions, such as entrepreneurs and venture capitalists. [22] Etzkowitz defines the university-industry collaboration as the most important dimension of an innovation ecosystem. The collaboration between universities, as non-profit organisations, and industries, as for-profit organisations, accelerates innovation making. [23]

Estrin points out a different viewpoint on innovation ecosystems on national level. She suggests that innovation ecosystems are communities consisting of people with different skills and know-how. In her definition the most important communities are research, development and application. According to Estrin, to maintain an innovative environment within an innovation ecosystem, continuous and balanced sharing (Estrin uses term cross-pollination) of ideas, questions, knowledge and technology, must occur. Every community in the ecosystem should also get enough benefit of the profitable structures in the ecosystem such as leadership, funding, policy, education and culture. [25]

1.2 Innovation

Co-creation is a concept, which occur in the innovation literature constantly and it is for a reason, since in today's technology world it is difficult to build successful innovations without collaboration. This chapter introduces the definition and evolution of innovation.

1.2.1 The Definition of Innovation

The term innovation has been defined in the literature from many different angles and has been an area of interest for the industry and among researchers. According to some researchers, the way innovation is defined within an organization will lead the

development of the company. What kind of results the innovation activity gains to the company is based on the definition of innovation inside the company. Innovation as a process, is complex and multidimensional because of the different factors affecting it. Often companies that encourages to innovative thinking are the companies who will innovate quickly and successfully. Innovation needs ability to transform gained knowledge and new ideas into new processes, systems or products. Academic literature defines innovation as new ideas or improvements that are useful. In this sense all new ideas or solutions will not be automatically defined as innovations, only if they are beneficial for its user. Innovations are seen beneficial both for companies and nations as they are often creating value and enhancing competitiveness. [26]

1.2.2 The Evolution of Innovation

Innovation has been evolving through the years and is constantly developing. At first innovation was a phenomenon where the companies tried to figure out new technologies or products. Inside the company innovation was perceived as a secret project. After companies realised innovation needs collaboration and external sources, open innovation was discovered. Before discovery of open innovation, innovation was usually performed inside the companies or in closed groups of individuals or scientists. Naturally, the term "Closed Innovation" was not used before the discovery of open innovation. Henry Chesbrough specified closed innovation for the first time in 2003. Chesbrough describes closed innovation to be handled in control and requiring the ownership of Intellectual Property (IP). The innovation process was successful when the company had full control of the creation and management of new ideas. Chesbrough defines innovation as deliberate external and internal knowledge which gains the internal know-how to be able to produce innovations for external use. [27]

Open innovation is a model of innovation where the innovation process is carried out together with several Research and Development (R&D) actors. This type of open innovation will shorten the innovation time and benefit the actors when the risks and costs in the innovation process are shared between all the stakeholders. Open innovation will benefit the actors also when accessing to the market with the final product. When the Intellectual Property Rights (IPR) belongs to several owners, it makes the market free from a monopoly setting of a specific technological field. Costs of internal R&D and innovation has increased, however Small and Medium-sized Enterprises (SMEs)

and research and technology organisations (RTOs) are still performing high-quality R&Ds. Therefore, big industries have started to buy R&D activity from smaller companies to gain external knowledge and exploit it into their innovation activity. This has built up new collaborations between companies aiming to new innovations. Based on the European IPR Helpdesk open innovation has potential to facilitate the cooperation between companies and RTOs. [28]

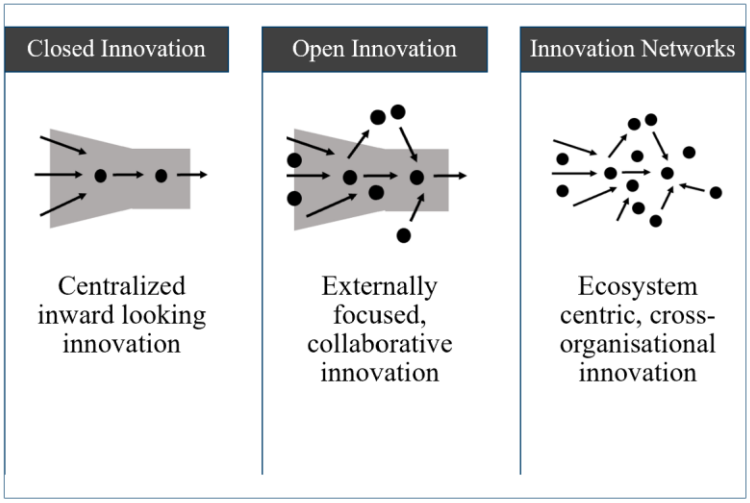

Figure 4: Salmelin's view how innovation has developed from Closed Innovation to Innovation Networks. [29]

After open innovation were discovered and deployed new methods for organizing innovation activities started to rise. Today innovations are often developed in various networks and ecosystems. Innovation ecosystems functions as cross-organizational platforms, architectures or systems where new ideas are generated together with the actors of the system. Co-creation and co-operation between different stakeholders is needed to be able to build successful innovations, therefore these kinds of networks are intended to gather all essential stakeholders together. [27] [30]

1.3 Health and Wellbeing Technology

Health and Wellbeing technology is a key actor to reduce increased health care costs and to develop new even better care for the patients. Both health care professionals and technology industry play an important role in the whole innovation process. Without the knowledge and expertise of health care professionals new and essential innovations would be difficult or impossible to identify. Technology experts on the other hand are

the actors who enable the implementation of new technology solutions and have the know-how to make sure the technology is safe in health care use, especially protecting patient and data security. Health and Wellbeing technology as a concept includes many different aspects but it can be defined as medical procedures, support systems and all drugs that are used to provide medical care for the patients. In this overview, few main components of Health and Wellbeing technology are described.

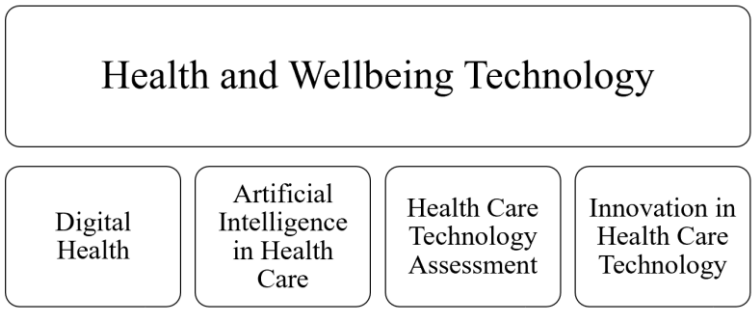

Figure 5: The framework of the background of health and wellbeing technology. Source: Author.

1.3.1 Digital Health

Based on different literature **digital health** can be defined as solutions and technologies, which are used to administer health services in a way, that improves the patient's health and wellbeing. Digital health systems also help to monitor the patient better and give the possibility for the patient's family to participate in the cure process. Robinson et al. defines digital health to be a way how use of digital media will change the way health care is understood and delivered. [31]

The methods used when delivering health care digitally are often called eHealth, mHealth or Health IoT. **eHealth** as a concept is often used when described the use of internet and other web-based technologies when delivering health care services. The term has been said to stem from the business industry and has been used similarly as the words e-commerce and e-business, therefore the term has been defined accurately in the academic world much later after the start of its use. Based on different literature sources eHealth could be defined as a growing field between medical informatics, public health and business. [32]

mHealth, based on WHO, is a component of eHealth but differs from eHealth in a way how health care services are administered with mobile devices. Based on WHOs

definition, mHealth is health care delivery supported by different mobile and wireless devices such as mobile phones. Health and wellness apps can be considered to belong under digital health as well. They can be described to be mobile applications, which are used to distribute different health information to the patient. And by that make the health management by the patient easier and more understandable. [33]

Health IoT or Internet of Things in health care is a rapidly growing area in health and wellbeing technology. Internet of Things (IoT) as a concept can be defined as connecting different smart objects together through an internet connection. This enables data collection through several devices, which in health care context could be for example different activity sensors or body weight scales. [34]

Connected health aims to change the health care delivery from a reactive model to a proactive model. This model would connect all stakeholders in the patient's care path and throughout the patient's whole lifespan keeping in mind that the patient is placed in the centre of the model. This model seeks to get patients and all other stakeholders more empowered. The central part in the cycle is the health data from the patient. The data can be anything from basic biomedical test data to mental health data. When all the information is gathered from the patient and possibly compared with other patients' data it is analysed, stored and shared to trigger interventions to make the care as proactive as possible. This kind of cycle thrives to make the patient the manager of his/her health status. However, some challenges have been recognised; the process of collecting health data from patient's need to be optimized and the large amount of data must be gathered and mined and then analysed to be able to get relationships between the health data collected at home and at community. [35]

Big data plays an important role in health and wellbeing technology as well, it can be defined as data or data sets, which are so large that it is difficult or unnecessary time consuming to work with them with a standard software. Based on literature big data has five different dimensions: Volume, Variety, Velocity, Veracity and Value. Big data can be related to predictive analytics and user behaviour analytics and to other data analysing methods, which uses large data sets. The innovative side of Big data is that large data sets can be used in a completely novel way. In health care context Big Data can be used to predict and prevent serious illnesses in patients. The amount of data is

increasing rapidly when data is gathered more and more from different devices. IoT and other wireless sensors collect data constantly. [36]

1.3.2 Artificial Intelligence (AI) in Health Care

AI in health care means computer science, which can analyse complex medical data and build relationships with the data sets so that it will be able to advice the user in decision-making. AI can also make predictions of outcomes in different clinical scenarios. AI can be defined as a field of science where the computational knowledge will be utilized to be able to understand and adapt intelligent behaviour. [38]

Modern medicine is facing challenges of analysing and applying the large amount of patient data. The mission is to be able to use and gain knowledge of the data collected from patients with different sensors and IoT equipment and to be able to solve complex clinical problems. With the help of AI the clinicians could get help in the formulation of diagnosis, decision-making and outcome prediction. Artificial Intelligence is designed to support the health care professionals every day work. Many different AI techniques has been recognised to be able to solve health care problems. However, the trust towards technology in decision-making still needs to be accustomed and proven by researchers. Nevertheless, literature already has evidence that AI in health care can provide the clinician efficient assistance in health care delivery. [37][38]

1.3.3 Health Care Technology Assessment

New medical devices are regulated by the Federal Drug Administration (FDA) but health care technology assessment is limited. Previously health care technology assessment was performed by federal agencies but today it is decentralized and more and more shifting to the private sector. Innovation activity is mainly taking place in the free market and marketed directly to the consumer. For providing proven safe and effective new technologies co-creation among universities, corporations and public administration is needed. [38]

In Europe the Medical Device Directive (MDD) is steering the medical device market. The purpose of the MDD is to standardize the requirements set for medical devices in European Union. CE-certificate can be issued to a manufacturer who fulfills the requirements set in the MDD. The manufacturer is legally responsible of fulfilling the MDD requirements. In Finland the public authority who is responsible for MDD

supervision is Valvira. The standards concerning medical devices are; SFS-EN ISO 13485, SFS-EN ISO 14971, SFS-EN ISO 15223-1, SFS-EN ISO/IEC 27001 and SFS-EN 62304, SFS-EN ISO 11073. A medical device is a product that is used in patient care or devices that are connected to the patient during the care process. The requirements concern instruments, hardware, equipment, software, materials and other accessory. The products are divided in four categories depending on how much of the assessment has to be done by an external Notified Body. [39]

1.3.4 Innovation in Health and Wellbeing Technology

As the health and wellbeing sector is facing major changes in terms of digitalization, new innovations to enable these new ways of working are needed. Often the demand for a new solution comes from health care professionals however often health care organizations does not have capabilities to develop the new solutions themselves. Therefore, health care providers need co-operation with first of all technology companies as well as other relevant stakeholders who has the expertise to enable new innovative solutions. In the health and wellbeing sector timing for new solutions plays an important role when developing new technology. If the innovation is on the market too early the supportive infrastructure may not be yet in place and on the other hand if wait too long the possibility for competitive advantage may have passed due to several reasons.

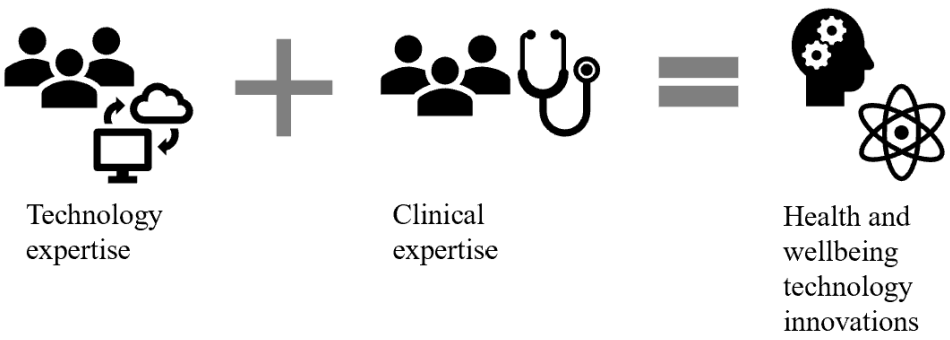

Figure 6: Innovation in Health and Wellbeing Technology. Source: Author.

Innovations are usually made for the citizens therefore new solutions should be implemented and designed with them. In the public-sector innovation the citizens ergo the users of the innovations play an important role as they are beyond the scope of the public sector and they encounter the effects of new policies and services. Involving

citizens more, the public-sector will increase their abilities for successful innovations. Bason highlights that the only way to enhance public-sector innovation is co-creation with citizens. [40, 41]

Even though innovations are seen in a positive light among health care professionals they still represent a multifaceted case. Some researchers explain the complexity of health care innovations through the difficulty to change the health care field; clinician's behavior, medical practices and health care organisations. When implementing new solutions to the health care sector several risks has to be considered such as health risks as well as financial, social and ethical issues. (Kent, 2001) Health care sector is also tightly regulated which makes it challenging to make changes to existing solutions. [42, 43]

1.4 Benefits of Innovation Ecosystems

Health care field is constantly developing, and new innovations, products and services are needed. Often these new innovations are invented through collaboration and that is why health care innovation ecosystems could bring remarkable benefits both for the actors in the ecosystem but for the health care field as well. This chapter introduces the benefits of innovation ecosystems.

1.4.1 Co-opetition and Competences

Bengtsson and Kock have found competitors collaborating and competing in innovation ecosystems. [44] This kind of interaction is called co-opetition which is a blend of co-operation and competition where these two actors should be in balance to create successful co-opetition relationships. Bouncken and Kraus have studied this phenomenon and presents that when there is an equal amount of co-operation and competition the mutual benefit will be greater than it would be without the co-opetition relationship. [45]

Bengtsson and Kock classifies co-opetitive relationships in three types; cooperation-dominated, equal relationship and competition-dominated relationship. The argument for the benefits of competition in co-opetition is that the actors are pursuing their own interest and therefore interested in competing. [44] When the companies practice co-opetitive behavior many benefits are achieved such as new knowledge, advantages of

external resources and competencies and reduction of costs and risks as they are shared together with the ecosystem actors. [46]

Eliasson has studied innovation ecosystems and how competences affect the operation of a network of innovative activities. Eliasson introduces competence bloc theory which defines what kind of actors and competences are needed to build up an effective innovation ecosystem generating business growth. The idea of the competence bloc theory is to find the firms internal strengths and to be able to use them in the ecosystem in an effective way. An organization should identify its key competences to be able to exploit the resources in most effective way. With use of key competences, it is easier to integrate the functions of different organizations together. [47]

Key competences can also help to find mutual interests and opportunities in innovation ecosystems. Competence bloc theory helps to lead the innovation project successfully to the production and distribution phase as fast as possible. In an innovation ecosystem it is important to identify the competences to be able to understand how the innovation ecosystem would function in the most efficient way. Identifying competences will help the ecosystem to understand how the capabilities, knowledge and know-how could be used and utilized effectively to be able to distinguish among other innovation ecosystems. With help of the competence bloc theory an ecosystem can create a competence set to help the strategic planning and regeneration of an ecosystem. [47]

Co-opetition in health care can be challenging however several authors have suggested some factors which make the knowledge sharing more successful. Complementarity, similar cultures and shared understanding of the demand are seen the most important factors for successful innovation activity and knowledge sharing. [48] To make the knowledge sharing successful and sustainable for the organizations a legal agreement is needed. The agreement should detail how the knowledge will be shared among participants. The agreement should protect the actors on risk taking and create a safe environment including a detailed process how to handle possible issues regarding knowledge sharing. [45][48] Knowledge sharing is seen one of the critical success factors of a successful co-opetitive relationships therefore it is important to make it safe for the actors through mutual legal agreements. In shared activities, such as innovation, added value and organizational learning plays an important role, these can be achieved by increasing knowledge exchange. This is clear because all the actors of an innovation

ecosystem have to plan their funding carefully therefore there is no room for wasting resources on solutions that already exists or have been explored already by other organizations. [49]

To be able to build well-functioning innovation ecosystems the ecosystem should function in an open-minded way so that the knowledge within the network is shared and taught forward. One important factor is the trust among the partners. Trust should be fostered along the whole innovation process and inside the whole ecosystem. The performance of co-operative behavior increases when partners trust each other, and it also reduces misunderstandings and conflicts. [48] [49]

1.4.2 Innovation Ecosystem Success Factors

Every organization has its own way how the innovation process is carried out. Innovation ecosystems brings new ways of thinking and viewpoints to the innovation process therefore new ideas from outside makes the innovation process more beneficial for all participating organizations in the ecosystem. One key element making co-creation successful is combined resources and capabilities. Based on Adner and Kapoor's research an innovation often needs, not only success in the internal environment, but also success in the external environment to be successful. [24] Letaifa states that close collaboration makes value creation and success viable as the success of ecosystem actors is dependent of each other. [18] Adner and Kapoor has studied especially Innovation Ecosystems and have found that Innovation Ecosystems does not consider only innovation and its challenges but makes linkages to the restrictive phenomenon in the company's ecosystem as well to make it easier to understand interrelations between actors. [24]

Ecosystem activity creates new connections which enables new possible markets and contacts which otherwise could have been difficult or impossible to create. Baptista and Swann have studied clustering in computer industries and have found that strong clusters draw more easily new members along. Baptista and Swann found also that firms who are part of strong clusters tend to grow faster than firms who are not. The most important mission of an ecosystem is to create value through collaboration. One value which thrives the ecosystemic thinking is cost efficiency. The ecosystem actors work in co-operation to achieve the shared jointly applied objective. This kind of

collaborative activity reduces the amount of investment and reduces the risks of an individual actor as they share the objective. [50]

Edquist has studied innovation systems and specifies several strengths concerning innovating together with several partners. The first one is that when co-creating with other companies the innovation and learning process is the main focus. As the collaborating actors want to get value back of their investment some new knowledge must be shared between actors. Innovating in a team which has actors from several fields makes the viewpoint wider and gives it interdisciplinary perspective. Co-creation highlights also interrelation and non-linearity as innovation need information about relations between elements in it. Innovation ecosystems can be seen dynamic compared to the nature of innovation since an ecosystem structure is changing according to new demand and new conditions. Innovation process needs distribution of work between public and private organizations. In an ecosystem, small enterprises have a possibility to be more operative which gives them possibilities to succeed better on the market. [51]

Ecosystem activity helps companies to build new connections and to reform their businesses. For an innovation ecosystem it is important to find the most suitable partners to co-operate with, find a well-functioning and efficient management and business models. An innovation ecosystem is not either juridically an organization which also sets its own challenges to the management model. The nature of innovation is systemic in a sense that companies need collaboration and interdependence with other organizations and institutions to make successful innovations. Institutions plays an important role in the innovation process as all the laws, rules, routines and norms effect on how the organizations can participate and co-create. These institutional matters can also build obstacles and roadblocks for the innovation process. [51]

Actors in an innovation ecosystem are independent but they combine their resources and capabilities to achieve optimum outcomes. Adner and Kapoor states that innovations in a firms external environment affect the firms individual ability to innovate successfully. Therefore, the location of an innovation ecosystem matter as the delivery of components and other complementary products should not complicate the innovative activities. [24] It is believed that when the level of clustering is high it will increase the output of innovations due to increased interactions between the actors. Furthermore, the most

important dimension of an innovation ecosystem is the university-industry collaboration. [52]

Barretta have studied how innovation activity in organizations should be planned. Firstly, the innovation method should be chosen, how the innovation process will be carried out. Secondly, innovative spaces should be considered, whether they are needed and how they should be executed. Thirdly, consideration of how a robust innovation network should be built. The cornerstone of innovation ecosystem activity is to have a view of how the innovation activity will be built up so that it will benefit all stakeholders in the ecosystem in a way it will maximize the benefit of the own organization. [48] Valkokari emphasizes that for an ecosystem actor it is necessary to understand that different ecosystem types require different kind of interaction. When an ecosystem actor has assimilated this fact, it will survive and succeed in the ecosystem. [8]

When strengthening the dynamics of an innovation ecosystem it is challenging to find a way how all reached issues can be fulfilled. The reached issues can be carried out when the ecosystem has enough competences and resources and when they have a common nominator so that the direction for all parties are same. In other words, although the companies within one ecosystem may have different aims to participate in joint development projects one common interest should be identified within the ecosystem.

Literature introduces various studies about factors of a successful innovation ecosystem. Durst and Poutanen have listed the main dimensions under which the main success factors can be found. The table below will introduce the nine success factors.

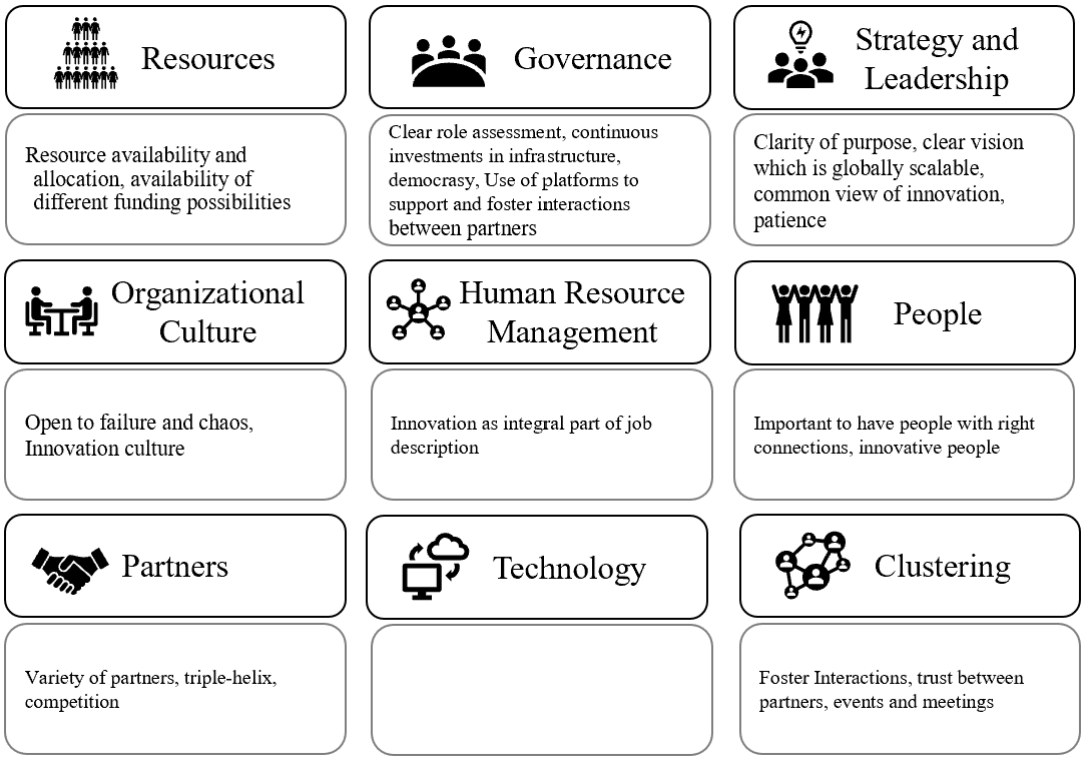

Table 2: Nine critical success factors of innovation ecosystems. [9]

Resources and resource allocation are important elements to be able to manage innovative development projects therefore this dimension is seen relevant to mention when talking about success factors of innovation ecosystems. However, especially governance plays an important role in the ecosystem structure since managing the challenges concerning communication between the ecosystem actors need to be taken care of properly. Structural and technological aspects as well as data management and data analysis affiliates under the governance dimension. Governance covers also the issue of flexibility in the ecosystem which are seen an important factor for a successful innovation ecosystem. [9]

Human resource management covers the idea that innovation should be an essential part of job descriptions. The dimension of people represents the importance of right people who has connections to relevant other networks which are essential for research for instance. The relevant partners play an important role in the ecosystems success as well. The dimension of clustering stands for networking and interactions which are extremely important to cherish an open and innovative environment. [9]

The main objective of ecosystem thinking is to expand the skills and forces from different actors to be able to create shared value. [24] The existing literature about innovation ecosystems shows that ecosystems are considered useful, but their utility is not dependent on the use of the "eco" prefix. It is also difficult to say whether all studies using term innovation ecosystem refer to the same kind of ecosystem thinking. [3]

When measuring the success factors of an ecosystem, it is worth noting that it should not be approached too linearly, or else it may result in too absurd results and distorted benchmarking. This is because the ecosystem is not a simple system whose inputs and outputs are predictable and clear. [53]

Literature does not show enough studies whether innovation ecosystems vary from country to country therefore this research will compare different ecosystems from different countries trying to find success factors that remain constant under different conditions.

2 BACKGROUND OF CLEVERHEALTH NETWORK

This chapter introduces briefly the Helsinki University Hospital (HUS) and the CleverHealth Network innovation ecosystem.

2.1 Helsinki University Hospital (HUS)

The health care in Finland is mainly provided by the public sector and the largest hospital in Finland is Helsinki University Hospital (HUS) which is formed by 24 municipalities and is offering specialized medical care for patients from the member municipalities. In the municipalities primary health care is provided by health centres and when the patient is in need of specialized medical care, he or she is sent to a hospital district hospital. Municipalities in Finland can run their own health care centres or in co-operation with other municipalities or in some cases buy all the services from private health care providers. Primary health care in Finland covers basic health care series, maternity and child welfare, school health care, medical rehabilitation and dental care. Municipality health care centres serve patients based on their own appointment to the clinic, but specialized medical care is served only to patients with a referral from a health centre or private health care centre physician. [63]

Specialized medical care is provided by 20 hospital districts from which five are university hospital districts. HUS is the largest university hospital and has in total 24 hospitals throughout the province of Uusimaa. A national agreement states that the most demanding or rare treatments and expensive illnesses are centralized at the hospitals of HUS. The responsibility of specialized medical care planning, direction and supervision are at the Ministry of Social Affairs and Health and on provincial level at the provincial governments. [63]

2.2 CleverHealth Network

Helsinki University Hospital (HUS), together with partner companies have established an innovation ecosystem, which is orchestrated by HUS and funded by the Finnish funding agency Business Finland. The operating model of CHN is data driven. The

ecosystem brings together clinical experts and researchers of HUS, health technology expertise from large corporations and SMEs and HUS's high quality health data storage solution (DataLake). The aim of the ecosystem is to create product and service innovations in the field of health and wellbeing technology by which improving efficiency and patients care. The ecosystem targets also to increase technology exports and to attract foreign investment to Finland. [64]

At the moment 14 companies, including HUS, are involved in the innovation ecosystem and in addition to this several other companies and research institutes will be involved in the sub-projects of CleverHealth Network. All innovation, research and development work will be carried out through sub-projects that are established within the ecosystem. The projects within CleverHealth Network will be focused on the HUS's special areas of knowledge, such as diabetes and cancer care.

The focus in the ecosystem is on the rapidly growing area, health and wellbeing technology. The aim of the ecosystem is to create an environment to stakeholders for product and service innovation. The environment includes both technical and functional fields where the clinical experts, researchers, academy and companies together can develop health and wellbeing products and services. HUS and the member municipalities works as pilot sites and will bring knowledge and resources to the ecosystem. HUS provides the information platform to the ecosystem which will be used in the sub-projects and to provide data. The platform will be useful for utilizing new innovations as well as for clinical activities.

CleverHealth Network provides different services for the ecosystem members such as project management, consultation, communication services, legal services and Product Development Manager who is in charge of ISO13485 certification tasks regarding the product and service innovations developed in the CHN projects. The aim of CHN is to expand the service catalogue while the ecosystem is developing.

2.3 CleverHealth Network's objective

CleverHealth Network aims to provide joint projects which will involve several partner companies and research institutes from the ecosystem. HUS will bring its know-how from several fields to these projects, such as clinical expertise, research and clinical test

environment. The ecosystem will utilize different technologies in the joint innovation projects and develop new technologies to the health care market. Large companies and small and medium sized companies can co-operate through the ecosystem and benefit each other. The ecosystem has its own steering group which coordinates and supports the projects and also makes decisions for instance on vision, operating models and co-operation rules. The steering group will act as a motivator and markets the ecosystem.

CleverHealth Network ecosystem has been established to make innovation in the health and wellbeing field easier and more beneficial for all the stakeholders. At the moment innovations are often developed in the private sector and the companies may have difficulties to get the new solutions tested in the hospital or health care environment. This is an indicator that some changes to the whole innovation process in the field of health care is needed. The main concern is that the health care technology industry will continue to lag in the innovation processes when the new solutions can't get in to the market early enough. CleverHealth Network tries to provide a solution for this issue.

3 METHODOLOGY

This chapter introduces the aim of the study, study design and the methods for data collection and analysis. The validity and reliability of the study will also be discussed. The author will also argue the process of selected innovation ecosystems.

3.1 Aim of the study

The aim of this master's thesis is to study existing health care and wellbeing technology innovation ecosystems globally and existing well-functioning innovation ecosystems in Finland. And identify the success factors which remain constant from country to another and from innovation ecosystem to another. Additionally, differences between health care and non-health care innovation ecosystems were examined. The methodology of this study is a qualitative research as it seeks instead of measuring to explain the characteristics of the current state. A qualitative study is suitable for research studies aimed at understanding, describing, explaining and interpreting phenomena and related practices and meanings. [54] This research is an assignment for CleverHealth Network to provide suggestions for further development needs.

The purpose of the comparison is to provide a suggestion for future development needs for CleverHealth Network (CHN) innovation ecosystem in Finland. To provide a wider view of different ecosystems, two health care technology ecosystems abroad and two non-health care technology ecosystems from Finland are chosen for interviews. The chosen innovation ecosystems are Welfare Tech in Denmark, Prime Health in US, LuxTurrim5G and One Sea ecosystems in Finland. Health care technology innovation ecosystems from Finland are not chosen because all the biggest ecosystems in Finland functions in a different way what CleverHealth Network is aiming for. For this reason, the chosen health care technology innovation ecosystems are from abroad.

These ecosystems are chosen because the aim is to investigate whether the interviews shows similarities or disparities between the most important dimensions of success factors globally and nationally and between the health care and non-health care

ecosystems. The aim is to provide a best practice for CleverHealth Network innovation ecosystem of how to plan the development and what have been the most important factors for other innovation ecosystems nationally and internationally.

The Finnish innovation ecosystem One Sea is chosen to the research based on the categorization by the Finnish funding agency Business Finland of growth engine ecosystems in to which One Sea belongs. One Sea is also the oldest ecosystem in the growth engine category therefore it is a natural choice instead of the other ecosystems in the same category. LuxTurrim5G is chosen because it has a similar structure of actors than CleverHealth Network is aiming for; a public actor, the city of Espoo, and companies of different size and fields. The city of Espoo also won an intelligent community award because of LuxTurrim5G ecosystem. Therefore, LuxTurrim5G can be categorised as a well-functioning ecosystem.

The steering group of CleverHealth Network want to get one ecosystem from US in the research and based on public information and the ecosystem's website Prime Health is chosen. As CleverHealth Networks aim is to develop product and service innovations for digital health the innovation ecosystem, Welfare Tech, from Denmark is chosen for interviews because based on The Digital Economy and Society Index (DESI) of European Commission Denmark is the most digital country in the EU. [55] Denmark is also ranked second in the Innovation Scoreboard (European Commission). [56] Additionally, other ecosystems were contacted but no response were received, therefore the sample size remained in four ecosystems (n=4).

The research has one main research question (RQ) and four sub-questions (RQ1.1 – RQ1.4).

- RQ1: What are the critical success factors when developing and maintaining a health and wellbeing technology innovation ecosystem?
    - RQ1.1: What are the success factors for innovation ecosystems based on relevant literature?
    - RQ1.2: Which factors are most important for the interviewed innovation ecosystems?

- RQ1.3: Which success factors remain constant from one country to another when comparing a health technology innovation ecosystem abroad to an innovation ecosystem in Finland?
- RQ1.4: Are there distinct disparities or similarities between health care technology and non-health care technology innovation ecosystems?

3.2 Study design

The basis of the data collection in this research is research interviews. The interview type in this research is thematic interview. The author will use the same themes in all four interviews; networking and clustering, learning and knowledge sharing, management and development. These themes played a very central role in the interviews as they were steering the interview forward. The author will introduce the interviews in more detail in the interviews section. [57]

The methodology of this study is a qualitative research as it seeks instead of measuring to explain the characteristics of the current state. A qualitative study is suitable for research studies aimed at understanding, describing, explaining and interpreting phenomena and related practices and meanings. [58]

3.3 Methods for Data Collection and Analysis

Data collection in a qualitative study can occur in several ways. Eskola and Suoranta mentions that the data in a qualitative study can be collected for instance through interviews, diaries, letters, articles, movies or advertisements. The data collection in a qualitative study is not limited only to academic articles. The data for this study will be collected at first through a literature overview about success factors of innovation ecosystems. After which deepening the understanding of innovation and ecosystem concept and looking for information of existing innovation ecosystems globally and nationally. [57]

The academic literature will be searched from Google Scholar and Pub Med databases using the following terms; innovation, ecosystem, cluster, network, triple helix, eHealth, mHealth, Health IoT, Big Data, Artificial Intelligence, innovation ecosystem, business ecosystem, knowledge ecosystem, digital health, health care technology, health and

wellbeing technology, innovation health care, co-opetition, competence and innovation ecosystem success factors. Other information is searched from the websites of selected ecosystems. After the review of existing literature, interviews from ecosystem partners will be carried out. The sample will be reached by contacting the ecosystems via their general email, web site contact box or via direct email to the ecosystem partners.

After the literature overview and interviews the collected data from interviews will be transcribed and compared with the data from the literature overview. The interviews are then sorted based on the success factors found from the literature and by using affinity diagram method. [59] [60]

3.3.1 Qualitative semi-structured interviews

In a qualitative study interviews are a common and popular collection method. Interviews can gather information, people's perceptions, beliefs, and understand why people or events work in a perceived way. The analysis of the interviewees confirms, questioned and further builds the theoretical background to the chosen topic. [61] The purpose of the research interviews is to deepen the image of these ecosystems and their processes in the theoretical part. Understanding seeks to identify how these ecosystems and ecosystem processes should be maintained and developed. Through interviews, information can be collected about the subject being studied, as interviews leave room for the emergence of new and surprising aspects during the discussion. Interviews can be used to create common meanings that positively influence the validity of the study. The aim is to strive for conversational interviews that go through certain topics.

The interview type of this research is semi-structured thematic interview. In a thematic interview, the themes of the interview, ie. the thematic areas have been pre-determined. In the thematic interview, the most essential thing is that instead of the detailed questions, the interview proceeds based on certain key themes. The thematic interview brings stricter limits to the interview situation than the open interview, but the structured interview offers broader opportunities to make individual interpretations. As innovation and ecosystems both are wide and differently understood topics, thematic interview leaves room for open discussion and gives opportunities to highlight areas which may not have been taken in to account when planning the interview topics. This gives more value of the interview to the researcher. [58]

The themes are selected based on academic literature of innovation ecosystems. The themes also include the topics of the nine success factors presented by Durst and Poutanen. The final analysis is carried out using only the three most relevant success factors; clustering, resources and partners. These factors appeared most frequently in the discussions with the interviewees. The interview questions are conducted together with the thesis supervisor Mirka Tammi from CleverHealth Network ecosystem. The interviewees will be selected using purposeful sampling technique. [54]

3.3.2 The implementation of research interviews

When choosing interviews as data collection method the first challenge is to get interviewees from the selected ecosystems. One criterion for the sample is that the person should be from the ecosystem or from partner companies and to have a broad view of the ecosystem's activity. These people usually are busy therefore all contacted ecosystem members were not even reached. After all the right contacts were found and all the interviewees had a broad view of the ecosystem activity and could answer well on the asked questions. The interviewees were contacted by email and the interviews of ecosystems located outside Finland were carried out as skype interviews and the interviews of Finnish ecosystems were carried out face to face in Helsinki.

The interviewee from Denmark, works as a chief consultant at the Region of Southern Denmark in Health and Social Care Innovation. The interviewee has been working the three last years in the field. The region of Southern Denmark is one of the partners of Welfare Tech. Welfare Tech is a nation-wide cluster located in Denmark and its aim is to promote business opportunities and collaboration between members and business partners both from private and public sector as well as research and education institutions.

Prime Health will be one of the interviewed ecosystems and the interviewee from there is the Executive Director of the ecosystem. Prime Health is a business ecosystem working on building a leading health cluster to US.

The interviewee from the Finnish LuxTurrim5G ecosystem is a principal consultant at Spinverse who is facilitating the LuxTurrim5G ecosystem. LuxTurrim5G is an ecosystem developing fast 5G network to smart cities and demonstrating it through

smart light poles which are integrated with antennas, sensors and other devices. The project is Nokia Bell Labs driven.

The interviewee from One Sea Autonomous Maritime Ecosystem is the Chairman of the ecosystem. The interviewee is in charge of innovation and technology of Rolls-Royce's marine business. Rolls-Royce is one of the members of One Sea ecosystem.

Title	Ecosystem	Country	Field	Interview Date
Chief consultant at the Region of Southern Denmark in Health and Care Innovation	Welfare Tech	Denmark	Health and wellbeing technology	5.10.2018
Executive Director	Prime Health	US, Colorado	Health and Wellbeing technology	25.10.2018
Principal Consultant	LuxTurrim5G	Finland	Networks / Digital Smart City	4.2.2019
Chairman of the ecosystem	One Sea	Finland	Maritime	27.2.2019

Table 3: Summary of the interviewees. Source: Author.

3.4 Affinity Diagram method

Affinity diagram is used to organize the results from the interviews based on the found literature. Affinity diagram method is often used in project management when there is need to organize new ideas and data. The method is invented by Jiro Kawakita in 1960s and also called as KJ Method. With the help of affinity diagram ideas and facts can be sorted into groups based on their relationships. After this the data can be analysed and reviewed. This method is used also in a way to organize notes from interviews. [59][60]

The method has three steps;

1. Write each idea/fact on card
2. Sort ideas that are related
3. Sort all card in to groups

After all cards belong in some of the groups, the groups can be further divided in to subgroups if it helps the analysis work. When the analysis is carried out the affinity diagram can be used to draw a cause and effect diagram. This method is used in this research as it is a good and clear way to sort the data from the interviews. The aim is to find similarities and disparities from the ecosystems so in that sense this method also helps to find out what topics were frequently arising from the interviews. [59] [60]

3.5 Validity and Reliability Assessment

Validity and reliability have been the methods when assessing the feasibility of the study methods. Validity means how well the chosen study method really measures what it should be measuring. Reliability means how well the study can be repeated which means how reliable it is. These methods have been criticized because these methods were first used in quantitative studies and applying these to qualitative studies is often not straightforward. For instance, when it comes to reliability it can be difficult to verify it as the circumstances and interpretation of studied cases can and will differ. [61]

When it comes to the research interviews Silverman highlights the impact of the interaction between the interviewer and interviewee to the interview results. The author will combine both the interview results and the data from academic literature therefore the research material can be seen reliable. [62]

The people who were interviewed from the ecosystems were in different positions and looking the ecosystem from a different perspective. This have possibly had an impact on the results and on the information, they could give regarding the ecosystem activity. Because of the variability in the perspectives and the small sample size (n=4) it is difficult to draw reliable conclusions. To increase the reliability in the study the sample size should be larger. The low sample size in the study were chosen to be able to get a deeper understanding of the specific ecosystem's therefore too many ecosystem interviews could have possibly distorted the results.

The ecosystems were chosen based on the CleverHealth Network steering groups interest. Other ecosystems were also contacted but they did not reply for the contact. The public information of the ecosystems online varied therefore it could have affected the image the ecosystem gave based on that information. The use of terms in the

interviews may also affect the results, as the definition of ecosystem is not clearly interpreted globally, it may have and distortive effect on the results. The chosen ecosystems may not be fully comparable either as they were from different countries where the health care models are different. As only four ecosystems were studied and compared therefore the results can be one-sided.

The author interviewed all the interviewees and interpreted all the data alone therefore in either of these processes' misunderstandings may occur. Also, two of the interviews were carried out in Finnish which is the authors native language and two of the other interviews were carried out in English. This difference may occur misunderstandings in interpreting the material from the interviews.

3.6 Restrictions

Innovation ecosystems are not a new topic and have been studied a lot before. However, the terms innovation and ecosystem are interpreted in many ways. Especially the term ecosystem has many different interpretations and does still not have a common globally accepted definition. Therefore, the found literature and interviewed ecosystems may differ regarding the definition of innovation and ecosystems.

Getting in contact with ecosystems proved to be challenging therefore the number of interviews had to be restricted in to four. This places an important restriction for the research as the interviews are carried out only of four ecosystems which were chosen based on the information available online. For instance, the author may not have found all the information needed from the websites or may have misinterpreted it.

The author could find only one study which had studied and sorted success factors of innovation ecosystems therefore the success factors used in this research are based on only one study which can give one-sided results.

It was difficult to reach the ecosystem members and get them to provide their time for the interview. The four members who were interviewed were open minded and positive towards the interview. However, the interviewed people from the chosen ecosystems had different positions within the ecosystem and may have looked the ecosystem activity from different perspectives. This may have affected on the results and how they have answered to the questions.

The chosen three factors were the most important factors for the four ecosystems, however if some other four ecosystems would be chosen the results may have differed. Therefore, this is an important limitation for the study. The study was also carried out and analysed by the author alone, therefore the results could vary if the research would be repeated by someone else. The topic is dependent by the environment of the ecosystem and as stated in the literature innovation can't be measured linearly therefore it is difficult to set strict measures for the study.

4 FINDINGS

The purpose of this chapter is to gain new knowledge of the studied phenomenon with help of the qualitative research. The research interviews have been conducted as thematic interviews to four different innovation ecosystem partners. The results from the research interviews will be compared with the information gained from the theoretical framework of ecosystems, innovation and health and wellbeing technology.

4.1 Success factors

This chapter will introduce the success factors which appeared most frequently in the discussions. The aim of this chapter is to have a dialogue between the results from the interviews and theoretical framework. Affinity diagram will be used when analysing the results and based on the analysis three success factors appeared most frequently in the interviews. The results will be presented in the following sub-sections.

4.1.1 Clustering

Based on Mercan and Götkas study when cluster level increases innovation output increases. This is due to more interactions between the actors. Mercan and Götkas also states that the most important dimension of an innovation ecosystem is university-industry collaboration. [52]

The need for clustering comes from the fact that enterprises need to co-operate together, both in between companies on for example innovation, but also on export or in joint projects tested in the real environment as usually the hospitals are public. Welfare Tech ecosystem in Denmark utilises the triple-helix model effectively when trying to innovate together with the enterprises. They have found that the strength is that the partners from the triple-helix works together most of the time.

> *"We work constantly with in the triple helix model. We have to have enterprises involved in this innovation triangle all the time, because they should not just invent things that are not useful. And they should develop these solutions together with both patients or citizens and staff at hospitals or different social*

care institutions. You have to have this triangle all the time, they should not work from each their corner they should work together in order to develop these solutions. This is the overall thinking of this ecosystem and I think the strength is that they work together most of the time."

Welfare Tech has a wide network and does collaboration with other cluster organisations in Denmark. For example, when trying to find new partners for the projects it is important to have a wide and variable network. Also, when innovating some novel solutions often the expertise comes outside the field and then it is valuable to have connections to other fields and other clusters.

"I think that it is a very agile way of working that you see how these different technologies can be used in specific field you have to have a wide network to be able to involve other sectors. I think they are succeeded rather well in that area because they have huge network and they have collaboration with other cluster organisations in and outside the country."

To be able to strengthen the ecosystem, clustering and fostering interactions are important. In the field of health care research and development need to be done but also the input from enterprises is needed as the public sector itself does not have the expertise to innovate alone.

"We know that we cannot do the innovation on our own we need to be in contact with enterprises and also on the other hand we need to involve research institutions, educational institution, in order to get both available knowledge and you also have to educate people in this area to strengthen the ecosystem."

The hospitals working with Prime Health ecosystem have gained huge value of the new connections and interactions, especially with other hospitals in US. Clustering activity helps to prevent the formation of siloes inside the hospitals.

"These hospitals see a value of being part of the ecosystem because they get to talk to their fellow hospital leaders and hear what some other hospitals are doing and then they also usually have their internal innovation network, not all the time but the larger hospitals have an

innovation group in help and those teams are kind of siloed within their organization."

The events Prime Health are organizing brings people together to discuss and to connect to each other. One important point also rises from the interviews regarding the common language, which can be connected to clustering.

> *"I think learning the language in health care is a huge area of need, because it depends if you are going to deal in mental health there are probably 500 pages of acronyms. So, when the companies participate in the events they learn the language and it is easier to identify needs and maybe the hospital will hire those people."*

Even though Prime Health is organizing events where the partners can meet and interconnect, still more brainstorming is needed. This also tells that clustering and connections with the partners are seen valuable.

> *"One area that we have seen some interest in is there a way for health care organization to come in and say that we have this problem and this data available and can we do more of a bringing people to the table to develop a company or an idea. I know there is a number of different companies doing that but we haven't seen it in the area of health care."*

New innovations may be in that kind of areas which haven't been discovered yet in that specific field. For instance, autonomous ships in the maritime industry was a new field when One Sea ecosystem started their activity. Therefore, right connections with ministries for instance are important. One Sea ecosystem emphasize the importance of sort of clearing the way for new innovations by affecting the laws and standards in the field. This would not be possible without clustering and wide connections nationally and globally.

> *"We have been actively influencing on international regulations regarding maritime industry. For instance, I was last year speaking at an international navigation association for 45 minutes in front of 172 countries in London. The change went through and Finland was the first*

chairman in this kind of exercise where all legislation regarding navigation are identified"

The partners in One Sea ecosystem have achieved great achievements during their participation in the ecosystem. Of course it can't be confirmed whether the achievements are achieved only because they were part of the ecosystem or not. Based on Baptista's and Swann's study firms who are part of strong clusters tend to grow faster than firms who are not.

"What it comes to business activities of our partners, in 2018 all of our partners achieved big accomplishments; Cargotec was the first non-Norwegian company who got an autonomous port activity, ABB drove the Suomenlinna ferry autonomously in Finland, Wärtsilä drove an Offshore ferry remotely at the North Sea and Rolls-Royce operated a Finnferries ferry autonomoysly."

4.1.2 Resources

In an ecosystem when the resources are shared it automatically makes the risk for the company much smaller than if they would make it alone without the network. When the companies practice co-opetitive behavior many benefits are achieved such as new knowledge, advantages of external resources and competencies and reduction of costs and risks as they are shared together with the ecosystem actors. When maintaining and building an ecosystem resources plays a central role. To be able to implement new solutions and maintain the ecosystem activity first of all different kind of funding possibilities and enough resources are important aspects. Welfare Tech, Denmark has built up a well-functioning ecosystem activity when they have been able to fund the projects.

"We had some different actors but they were not very closely working together so we have pushed forward this ecosystem to work together by funding different initiatives so we can strengthen it. That's the whole point of this smart specialization strategy, the overall target is growth and increased productivity and increased number of jobs and that's the overall target of everything we are doing in this field."

Enough of resources are a corner stone for every innovation process. Whether it is employees or funding, it is needed to be able to carry out an innovation project successfully. It is sort of the first critical point when setting up a project. It is also difficult to screen which project will get funding and which not, sometimes the potential can not be seen beforehand. Prime Health works across the different industries trying to identify the applications they receive.

> *"The Health care professionals come together and tell us what their priorities are so like they'll tell us that we want to improve outcomes in mental health treatment procedures and workflows and we'll put that out when we are sourcing applications, we'll put that out in our messages so that any startups involved in mental health are applying so that the mental health center of Denver for example can see all those applications. From Prime Health side, we are not going to tell hospitals with which startup to work with. Prime Health has problems with that, the issue is that, startups need that funding but from the hospital side they want to be able to evaluate without investor so Prime Health works across all the different accelerators, investor groups trying to identify the applications."*

Resource allocation and availability when sharing the resources is important and should be assessed properly. When working in a sensitive area such as autonomous vehicles or health care some supportive tasks should be taken in to consideration. These supportive tasks could be for instance correcting the misunderstood perceptions of sensitive topics such as autonomy. One Sea have allocated resources on these tasks:

> *"Even if the ecosystems main purpose is something you have specified it might be beneficial for the ecosystem members to invest in for instance correcting misunderstandings in the internet, communication. Also on standardization in the sense that the language when speaking of it would be uniform and by responding with facts to the sensitive topics drive forward the mutual benefit of the ecosystem."*

One Sea ecosystem have allocated enough resources to tackle different issues to be able to help the progress of the projects within the ecosystem. One aim for the ecosystem is

also to influence for instance on regulations in order to clear the way for the projects. This is also beneficial for the partners of the ecosystem when they will get this as a service from the ecosystem. One Sea have formed working committees which are all specialized in different issues.

> *"The majority of all the work within the ecosystem take place in these working committees. We have different working committees which are specialized in different tasks. I am a member of Operations committee which is more like business oriented. Then we have authorities where we have public and private stakeholders along. Standards committee is specialized on autonomy and technical standards for instance. Then we have ethical committee which focus on ethical issues. Our aim is to remove all legal, technical, commercial and ethical barriers by 2025."*

4.1.3 Partners

New innovations often are implemented by using outside the box thinking. Therefore, it is important to understand the importance of right partners. In an ecosystem variability is a key factor. Welfare Tech were planning a project where they wanted to utilise the expertise of big data. However, they could not find a company that would have been specialized in health care big data. They still found a company from another field who had a way of handling big data. This is a really good example how some company from a very different field can have just the right expertise for some specific task in a project.

> *"I know about a project they were supposed to set up a project on big data and they wanted to do that but they had difficulties in finding companies that were working with it, its tricky in Denmark and in many countries but they had a company joining this project that had experiences from it from another field, they receive a lot of data all the time and they had a way of handling big data even though it was not from the field of health and social care technologies they joined this project, it was sort of side stepping because it was not their field of competence but the big data and handling of big data, this was their field of competence. And there you see that perhaps other companies, smaller companies developing for example sensors that are used to handling different*

issues like heating in both houses and whatever it can be used in many different ways and perhaps also in the field of health technologies because the sensors are so to speak things that can be used all over in very many different fields."

An ecosystem works in a completely different way when there is enough of competition between the ecosystem partners. Bouncken and Kraus have studied co-opetition and presents that when there is an equal amount of co-operation and competition the mutual benefit will be greater than it would be without the co-opetition relationship. [45] Therefore it is important to involve the right partners in the ecosystem form competing companies as well. One Sea ecosystem have gathered all the competing organisations along.

"*At the beginning we had some companies who wasn't interested in joining the ecosystem and we had to call back and ask whether they really were sure they don't want to participate. And then I tried to explain how the ecosystem will be stronger when we are here all together. There might be different kind of ecosystems but when you get all the competitors in the same ecosystem, then the activity is totally in a different scale than it would be without all the competitors."*

4.2 Summary of the analysed success factors

This chapter analyses the results from the interviews and tries to answer the research questions regarding success factors of innovation ecosystems and the similarities when comparing ecosystems in Finland and abroad. The chosen success factors; clustering, resources and partners appeared in all four interviews and were most important factors for the ecosystem.

The author conducted an affinity diagram of the results from the interviews and categorized the findings under Durst and Poutanen's dimensions of success factors. Three dimensions appeared most frequently; clustering, resources and partners.

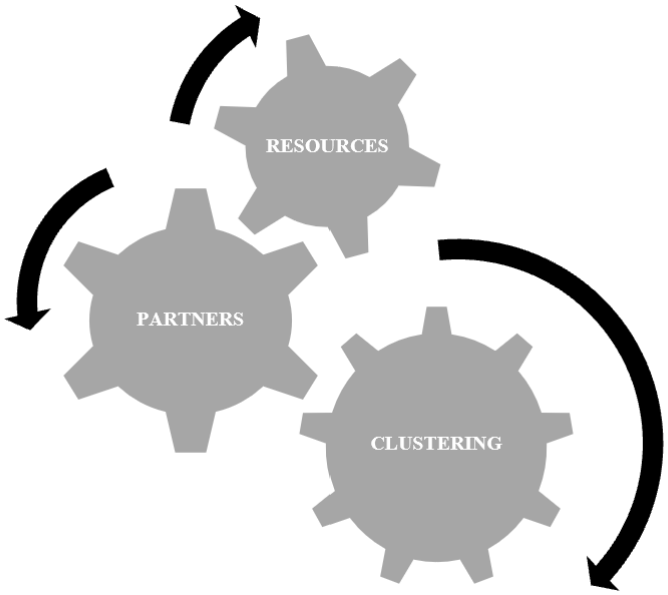

Figure 7: Three success factors which appeared most frequently in the interviews. Source: Author.

The success factors introduced in the research are found from the literature and the comparison is based on these factors. The author will also discuss suggestions of development for CleverHealth Network and propose needs for further research. The main research question and four sub-questions in this research were:

The sample size of this research was four innovation ecosystems (n=4) and they were interviewed and based on these interviews three success factors appeared most frequently in the discussions. After the author had conducted an affinity diagram of the interviews the results showed that clustering, resources and partners played the most important role in the interviewed ecosystems. These three dimensions stayed also constant between all the ecosystems and between the different countries. Based on this research these three dimensions stayed also constant between health care and non-health care technology innovation ecosystems.

Based on the interviews, new connections, meeting different stakeholders and getting to talk with fellow colleagues were important aspects why the partners participate in the ecosystem activity. These above-mentioned aspects belong under clustering which was one of the three most important success factors. Resources were mentioned in all four interviews and were a corner stone of the ecosystem projects and of the ecosystem

activity. First of all, enough resources is the foundation to be able to form projects after which right kind of resources to right tasks plays an important role as well.

To be able to innovate the importance of triple helix thinking was rising from the interviews. Especially in the health care technology innovation ecosystems the need for other experts than health care experts were seen important. Also, the two other ecosystem interviews showed that different kind of partners is important for gaining new knowledge.

RQ1: What are the critical success factors when developing and maintaining a health and wellbeing technology innovation ecosystem?

The aim of this master's thesis was to study existing health care and wellbeing technology innovation ecosystems globally and existing well-functioning innovation ecosystems in Finland. This chapter attempts to answer the main research question with help of the four sub-questions. The most critical success factors when developing and maintaining a health and wellbeing technology innovation ecosystem are clustering, resources and partners. Other factors may also be important, but this study showed that at least these are the factors which should be addressed properly.

For an innovation ecosystem to be successful, it is important to foster interactions between the partners as well as outside the ecosystem. Resources are a critical factor to be able to carry out projects and maintain the ecosystem activity. Partners plays an important role especially when planning projects and for the ecosystem to be valuable for the partners it is important to have different skills from different fields.

RQ1.1: What are the success factors for innovation ecosystems based on relevant literature?

At first the author conducted a literature overview of the success factors. The author could find nine critical success factors when developing an innovation ecosystem. The nine factors are introduced by Durst and Poutanen in their research and they are:

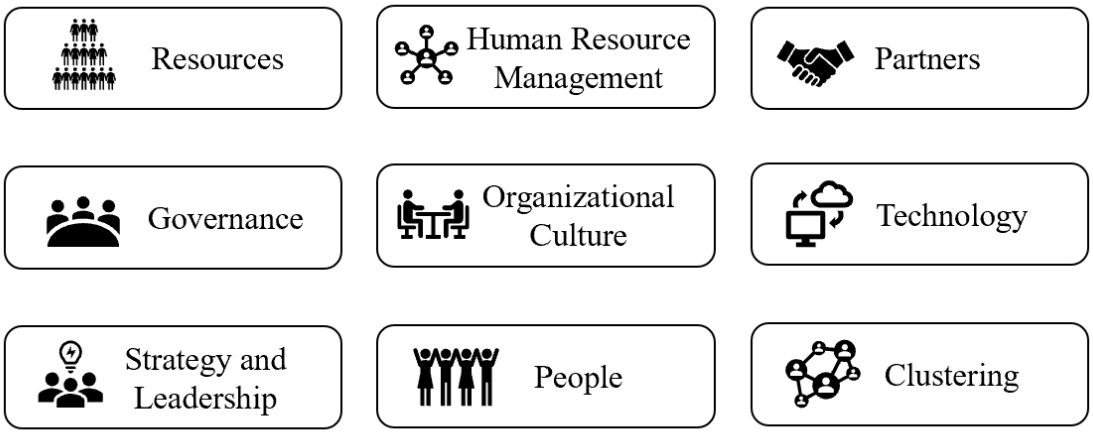

Figure 8: Nine most critical success factors of innovation ecosystems introduced by Durst and Poutanen.

RQ1.2: Which factors are most important for the interviewed innovation ecosystems?

Based on the information found from the literature the author conducted semi-structured thematic interviews for four innovation ecosystem members. Based on the interviews three of the success factors appeared most frequently in the discussions. Affinity Diagram were used to analyze the results and the topics interviewees pointed out most frequently were clustering, resources and partners. Therefore, these three factors were chosen for further analysis. The results from the interviews indicate that these three success factors are the most critical when developing and maintaining an innovation ecosystem. However, it is still important to assess the factors to the specific needs of the environment of the considered ecosystem.

This research showed that clustering, including interactions, is an important aspect why the partners want to participate in the ecosystem activity. Otherwise companies are quite siloed in their own spaces and do not co-operate, especially not with their competitors. Ecosystems make co-operation with competitors possible and desirable. Ecosystem activity creates new connections which enables new possible markets and contacts which otherwise could have been difficult or impossible to create.

Baptista and Swann have studied clustering in computer industries and have found that strong clusters draw more easily new members along. Baptista and Swann emphasized also that firms who are part of strong clusters tend to grow faster than firms who are not.

[50] All the interviewed ecosystem members said it is important to organize meetings and events to the ecosystem members as well as open events where other stakeholders outside the ecosystem can join. It has been also found that an important mission of an ecosystem is to create value through collaboration. The collaboration reduces the amount of investment and the risks are shared; therefore, clustering is seen an important factor for a successful innovation ecosystem. [50]

The second most frequently appeared success factor from the interviews were resources. All four interviewed ecosystem members emphasized that resources are the corner stone for to be able to carry out the projects within the ecosystem. Firstly, funding is the most critical part when designing the projects and the activity of the innovation ecosystem. Resource allocation played a central role as well. There should be enough of resources for ecosystem's fundamental activities as well as for the projects. Different fundamental activities within the ecosystem can include for instance working committees which aims to tackle the most critical issues regarding the field where the ecosystem is functioning in. In the health care technology sector these could be for instance GDPR issues or health care regulations. As stated in the background section in innovation activities added value and organizational learning plays an important role, therefore the knowledge change could be achieved by allocating resources for working committees. Resource allocation is important for the ecosystem partners especially when they must plan their funding, therefore there is no room for wasting resources on skills that already exists. [49]

The third assessed success factor was the variety of partners. The fact that the ecosystem activity is all about working with people, the variety of different partners is important. Based on Adner and Kapoor, new ideas from outside makes the innovation process more beneficial for all participating organizations in the ecosystem. They also stated that one key element to make co-creation successful is combined resources and capabilities. [24] Close collaboration makes also value creation and success viable when the success in the ecosystem is dependent on the success of the other partners. [18]

In this study all the interviewees mentioned that it is important for the projects as well as for the whole ecosystem to have special skills from other fields than the specific field where the ecosystem is functioning in. Additionally, the variety of skills and knowledge will increase the knowledge within the ecosystem. When planning a new project, the

ecosystem should assess the skills needed in that specific project and try to think whether there are some companies from other fields who have experiences in similar works previously. As an example, one interviewee gave a project where they needed skills of handling big data and could not find a company from the health care sector until they realized there are a company who does land surveying and has experience in handling big amounts of data but from a completely different field.

Comprehending the needed skills and competences of the project is important in order to gather a matching project group where all partners has their own field of expertise and enough of competences involved. This fact has been proved in the academic literature as well. Eliasson has studied how competences affect the operation of innovation ecosystems and created competence block theory. The idea of the competence bloc theory is to find the firms internal strengths and to be able to use them in the ecosystem in an effective way.

An organization should identify its key competences to be able to exploit the resources in most effective way. With use of key competences, it is easier to integrate the functions of different organizations together. Competence bloc theory helps to lead the innovation project successfully to the production and distribution phase as fast as possible. With help of the competence bloc theory an ecosystem can create a competence set to help the strategic planning and regeneration of an ecosystem. [47] Additionally, Edquist states that innovating in a team which has skills from different fields makes the viewpoint wider and gives interdisciplinary perspective. [51]

RQ1.3: Which success factors remain constant from one country to another when comparing a health technology innovation ecosystem abroad to an innovation ecosystem in Finland?

The three chosen success factors were chosen because they appeared most frequently in the interviews. Therefore, it indicates that the same factors also remain constant from one country to another when comparing a health technology innovation ecosystem abroad to an innovation ecosystem in Finland.

RQ1.4: Are there distinct disparities or similarities between health care technology and non-health care technology innovation ecosystems?

Based on this research it is difficult to state whether there are some distinct disparities or similarities between health care technology and non-health care technology innovation ecosystems. The main idea of an innovation ecosystem based on this study is the same regardless of the specific field of the innovation ecosystem. However, there are different aspects which should be taken in to consideration when innovating in the health care technology sector. Such as health data and the perceptions to use citizens personal data in innovation projects. Also piloting new solutions is not that straight forward in the health care technology field as it may be in other technology industries where there are not people's health involved. However, a deeper study on the differences between the ecosystem fields should be conducted.

5 DISCUSSION

There are several definitions of ecosystems in the academic literature and the term is used widely in the business world as well. The term ecosystem does not have one common and international definition. Due to this fact the found studies and ecosystems vary a lot regarding how the term ecosystem is used and what does it include. Some studies compare the different ecosystem types and suggest definitions to for instance innovation, knowledge and business ecosystems. However, these boundaries are not precise and can be difficult to implement in the real world as some of the components of all ecosystem types could be needed.

Ecosystem term has lately been a so-called trend word and many companies have started to use it to attract new businesses. This thesis studied existing health care and wellbeing technology innovation ecosystems globally and existing well-functioning innovation ecosystems in Finland and identified the success factors which remain constant from country to another and from innovation ecosystem to another. As the definition of the terms ecosystem, cluster and network is not precise it would be recommended to study the field more thoroughly and try to define the use of these terms.

The literature shows that the prefix “eco” does not add any value to the innovation ecosystem context. Therefore, the topic requires more research and definitions on the terms used. [9] To be considered is whether the analysis of the term ecosystem and its use in the business world has gone too pedantic. The concept of a biological ecosystem is also invented by human so the business world ecosystem concept could also be defined by human as precisely as possible. One argument why man-made ecosystems can’t be called ecosystems is that they are not self-directed, however it is still difficult to completely say how they evolve so in that sense they are partially self-directed. Does it matter if the man-made ecosystem is not completely self-directed and if the concept slightly differs from the biological ecosystem concept? The integrative aspect could then be the overall ability to evolve in a random direction depending on the environment.

Additionally, literature defines different types of innovation; however, innovation ecosystems usually are built around open innovation. Innovation can be specified to have different characteristics depending on the type of innovation and the organization or company considered. Some studies have shown that internal and external factors within a company influence the organizational innovation. Internal factors such as market orientation and technology policy will improve innovative activity within a company. External factors such as industry concentration also affects the attitude the organization has towards innovation. Innovation ecosystem is a multifaceted group whose focus is in co-creating novel innovations which creates business growth for the ecosystem participants. Usually an innovation ecosystem starts from one company who has an innovative idea and who needs partners to co-create the idea further with. This need of other partners usually leads to a small ecosystem where the idea is co-developed.

During the lifecycle of an innovation ecosystem some partners may join, and some may leave but eventually the ecosystem starts to create value. Ideally the ecosystem will expand to a commercial stage where the innovation ecosystem usually transforms into a business ecosystem. Innovation ecosystems has usually one keystone player who usually creates the strategy which coordinates knowledge flows and examines the possible challenges the ecosystem encounter.

From the health care sector perspective technology experts from the private sector are needed to implement the technological solution. Whereas the motivation for private sector companies for participating in the ecosystem projects can be the valuable validation for their solution. The private sector needs the clinical expertise to be able to develop useful and clinically validated solutions. A validated product or service has more value in the health care technology market globally.

Furthermore, based on the interview's resources played a central role among all the interviewed ecosystem members. If the ecosystem does not have enough of resources in use it is challenging to maintain and develop the ecosystem activity and start new projects. Therefore, funding possibilities should be secured at least on national level as well as on international level as well as possible. Naturally, it is difficult to predict whether a project or a solution succeeds but as mentioned in the background sector innovative activity needs risk taking. As a shared risk is a smaller risk an innovation

ecosystem can be considered a safer way for innovation for the partners. Allocating resources for different other tasks in the ecosystem were seen important as well. Especially one ecosystem partner emphasized that for the ecosystem partners it is important to get added value through the supporting services the ecosystem provides. These services would release ecosystem partners own resources for other tasks within the company and gain added value for the partners. When the ecosystem would function as preparing the environment for new solutions it could attract new members along as well.

Moreover, based on this research could be also concluded that all the three success factors contribute equally to the ecosystem. To be able to implement clustering and acquiring partners successfully, resources plays a central role. Durst and Poutanen's research indicate that Governance plays a central role in an innovation ecosystem however based on the interviews in this research governance did not rise from the discussions. Durst and Poutanen emphasized as well that the topic needs further research and that the amount of found articles on some specific topics might just indicate that they have been some researcher's personal interest areas. Therefore, a wider research on the topic is needed.

5.1 Suggestions of development needs for CleverHealth Network

Based on the interviews clustering in an ecosystem is important and one of the reasons why the partners are involved in the ecosystem activity. Fostering interactions within and outside the ecosystem is therefore important. Different events are the places where the partners and other stakeholders can meet each other and create new connections. Therefore, a suggestion for CleverHealth Network is to create more events where the ecosystem partners can meet each other and get new connections outside the ecosystem as well. The events could have planned themes for instance to acquire stakeholders from different fields. If some specific expertise is needed in some project, the events could be places where the experts of that specific field could be found.

The aim of an ecosystem, besides the original aim, can also be to kind of clear the way for the projects by affecting the environment where the ecosystem is functioning in. This means that the ecosystem could provide also other services for the ecosystem partners than the basic services regarding project management. CHN is already

providing additional services to ecosystem members, such as legal services, communication services, consultation and services regarding ISO13485 certificate. The partners have to plan their resources well to be able to gain value from being part of the ecosystem. To provide increased value for the partners the ecosystem could create working committees where all the most critical issues regarding the field of health care technology are discussed and solved.

The authors suggestion for CleverHealth Network is to allocate enough resources to tackle these issues. This could be implemented by at first identify the issues which should be addressed after which create working committees to further assess and work on these issues. The tackled issues could be for instance; GDPR in health care, Artificial Intelligence in health care, MyData in health care, laws and regulations in health care and misunderstandings regarding AI in health care.

The working committees, which will include stakeholders outside the ecosystem as well, will plan how these issues could be tackled. When these kinds of issues are taken in to consideration before the projects are ongoing it will be easier and faster for the projects to proceed. It can also be that some of the issues can't be tackled easily, then the working committee could think of alternative ways of proceeding in the projects. An example for tackling misunderstandings could be for instance to write blog posts in the CleverHealth Network webpage which contain facts about the addressed issue, such as AI in health care.

The variety of partners in an ecosystem is seen important both in the literature and from the interviews. The ecosystem actors should gain value from being part of the ecosystem and one way is to share knowledge within the ecosystem partners. If the ecosystem partners are all from the same field the amount of new knowledge is smaller. Therefore, acquiring partners from different fields would be important for CleverHealth Network. New partners could be involved either through the projects or from the ecosystem itself. In CleverHealth Network the new project ideas are introduced in the steering group meetings so the needed skills and competences could be assessed there or in the working committees.

The author suggests for CleverHealth Network to evaluate the needed skills within the ecosystem with the help of competence block theory for instance or a similar tool to

identify the needed skills. The needed skills can be evaluated project by project in the order new project ideas are coming or from the whole ecosystem perspective.

Conducting the interviews evoked difficulties due to low response rate of the contacted ecosystems and difficulties to find ecosystems which fill the criterions of a complete ecosystem. Some of the information received from the interviews are confidential therefore all the information could not be shared in this study. The use of term ecosystem may have also cause misunderstandings therefore the results of the interviews should not be considered too precisely. The fact that the term ecosystem is used widely with different interpretations could influence why the ecosystems were difficult to find or be sure they are functioning with the way CleverHealth Network is aiming for.

A strategic plan of the future of the ecosystem could be carried out where the skills and competences of the ecosystem will be assessed. When the ecosystem has a direction the missing competences and skills can be found via skills map where the existing skills and needed skills are mapped. After which the needed skills can be either provided by the ecosystem by new resources for the ecosystem or through new partners from different fields.

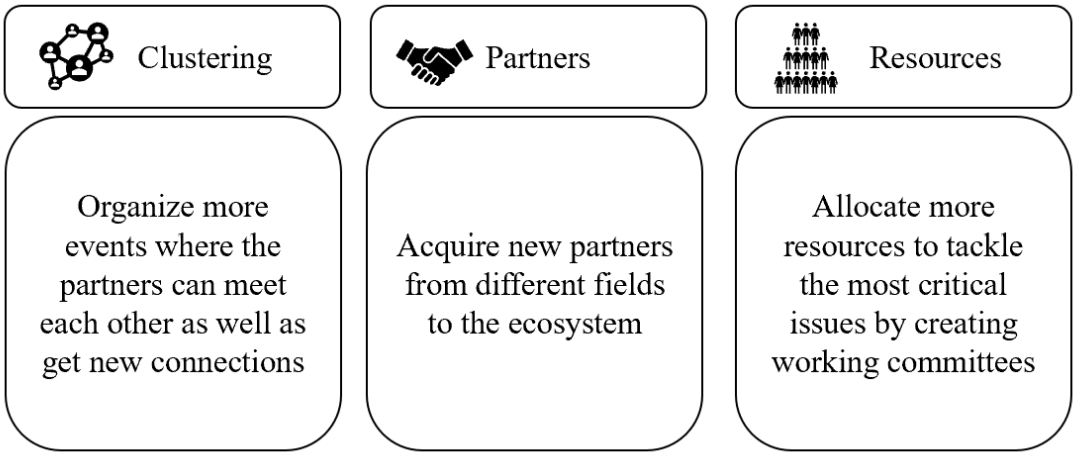

Figure 9: Suggestions of development needs. Source: Author.

5.2 Suggestions to Further Research

The author's suggestions for future research are to study further the three success factors; clustering, resources and partners. What is the best way to get funding for the

projects and how should the resource allocation be executed and into which tasks? Regarding clustering it would be interesting to find out how should the clustering be fostered and is there some specific ways to cluster as effectively as possible. Would it be tempting to organize also virtual events or are especially face to face connections more valuable. Would it be necessary to organize different themed events, such as events concentrating on artificial intelligence? Regarding partners, it would be valuable to study how new partners should be acquired to the ecosystem.

As a comparison it would be interesting to repeat the research with different innovation ecosystems, however retaining the same setting and sample size to be able to examine whether the factors remain same. Also, the six other success factors could be studied more thoroughly and study their significance beside the three success factors. Additionally, deeper research on the differences between a health and wellbeing technology innovation ecosystem and a non-health and wellbeing technology innovation ecosystem would be necessary.

Conclusion

This master's thesis is a contribution to the development of CleverHealth Network innovation ecosystem. The work will be beneficial for the CleverHealth Network steering group as well as for the CleverHealth Network Project Director who plans the further development needs of the ecosystem. This work will provide a suggestion of development needs; however, the more specific actions should be assessed more thoroughly by CleverHealth Network. This thesis will give an overview of the most critical success factors which should be addressed when planning the development of the ecosystem.

The author of this thesis studied the critical success factors when developing an innovation ecosystem at first through a literature overview after which through semi-structured thematic interviews. By comparing the academic literature and the information collected from the interviews the author chose three most important success factors and proposed suggestions for development needs for CleverHealth Network ecosystem. The author suggests that clustering, resources and partners are the most critical success factors when developing an innovation ecosystem and they should be assessed thoroughly when allocating resources and planning the activities of the ecosystem.

The author suggests CleverHealth Network ecosystem to foster clustering by arranging more events for the ecosystem partners as well as open events where other stakeholders can join and create new connections. Resources should be planned carefully, and enough resources should be allocated to fundamental tasks within the ecosystem therefore the author suggest CleverHealth Network to create working committees where all the relevant issues regarding health care technology field will be addressed in smaller groups. The author found that variety of partners in an ecosystem is important especially for the knowledge sharing. CleverHealth Network should acquire more partners from different fields to the ecosystem. New partners can be acquired for instance through open events or by conducting a skills map and trying to find the needed resources for the ecosystem or via new partners.

The use of term ecosystem has started to rise in the business world; however, the definition is contradictory therefore the academic literature gives variable information. The literature does not either define clearly the differences between network, cluster and ecosystem. The indefinite definition of the ecosystem has led to misinterpretations and the term has started to live its own life in different contexts. A more definite definition of ecosystem, cluster and network would make the environment easier to interpret and the discussion would be more systematic.

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Appendix 1 – Semi-structured thematic interview structure

Background

- Introduce briefly yourself and your role in the ecosystem?
- History of the ecosystem
- Why has the ecosystem been established?
- What have been major benefits of the ecosystem?
- Have there been some challenges?
- What is the operating concept/model and vision of the ecosystem?
- Who orchestrates/facilitates the ecosystem?
- Is the ecosystem functioning through projects? (several projects, or just one big project? What is the role of the ecosystem in the projects?
- How is the final product commercialized or is it?
- How many partners is involved and what kind of partners?
    - How many corporations, SMEs, startups and Universities?
    - From how many different fields or just from health care?
- Does the ecosystem have global partners actively involved?

Networking and clustering

- How was the network built up and how are the actors selected?
- To secure the fluency of the ecosystem activity which factors are essential when establishing new development activities?
- Does the network have a clear functioning model and vision?
- Is the activity open and does the ecosystem drag new partners along?
- How does the network communicate? How often does the network partners meet face to face?

- In what kind of events does the partners meet? (steering group meetings, other events, does all the partners meet all together?)

Learning and knowledge sharing

- Does the network have strong expertise from different fields?
- How does the learning take place in the network?
- Does the framework of the network support interaction and learning?
- What are the biggest challenges concerning learning in the network?
- How could the learning be improved?

Management

- Who is managing the network and what are the key tasks for management?
- Who has the ownership of the network and who is responsible of the network activity?
- How are the decisions made?
- How could the management be improved?
- What is the revenue model of the network?
- What services does the network provide for the partner companies?
- What is the difference between ecosystem projects and other innovation projects in your company?

Development

- How have you benefitted of the network?
- What have been the biggest challenges of the network activity?
- How is the network activity being developed?