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The Emergence of Digital Ecosystems

An Exploratory Case Study

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Executive summary

This thesis investigates the research question; *What factors need to be in place for the emergence of a digital ecosystem and how can the key mechanisms evolve?* The study is based on an explorative single case study of the establishment of a digital ecosystem surrounding welfare technology. Three respondents from the initiators of the digital ecosystem, one project leader on the demand side, and one respondent who is an expert within ecosystems and healthcare have been interviewed.

We have utilized existing literature on ecosystems, digital ecosystems and key mechanisms within ecosystems to create a theoretical background, thus enabling us to illuminate the research question. Research on ecosystems and digital ecosystems is limited, but sufficient to establish a basic understanding of the phenomenon. Nevertheless, there is a gap between theory and empirical evidence, especially related to the emergence of ecosystems and how key mechanisms can evolve. Therefore, the digital ecosystem presents an interesting object of analysis.

The findings reveal that there is an emergent stage before the birth of a digital ecosystem takes place. This embryonic stage is characterized by a complex problem and the need for an initiator to take action. The digital ecosystem emerges as a consequence to a complex problem, which necessitates a certain type of coordination. This coordination can be provided in ecosystems.

Through the establishment process, we found architecture and governance to be of importance. These mechanisms are expected to develop sequentially, as the full digital ecosystem develops. Additionally, competitive forces become an issue as the ecosystem matures and other actors see potential profits. Parallel to these phases is the continuous process of involving stakeholders. This is crucial to attracting the right technologies, which in turn comprise the value proposition delivered to the customer. These topics displayed interesting mechanisms that are crucial for the emergence— and development of a digital ecosystem. The findings are significant because they illustrate that digital ecosystems will have different versions of these mechanisms, and the mechanisms affect issues such as openness, control, coordination and innovation.

Preface

This thesis is written as part of our Master of Science in Economics and Business Administration at the Norwegian School of Economics (NHH) with a specialization in Strategy and Management. The study is part of a hub at NHH, the Digital Transformation Hub. Within this hub the study is part of *Digital Innovation for Growth* (DIG) which is a national research center that will focus on various aspects of digital innovations for sustainable growth. NHH, NTNU, and Telenor have formed the center together. Through our involvement in DIG, our focus has been to gain insight on the emergence of digital ecosystems. This thesis is a part of the preface of DIG, which further aims to increase the success rate for Norwegian digitalization initiatives.

We would also like to thank our supervisors Professor Lasse B. Lien and Professor Bram Timmermans for their valuable advice and feedback. Their support and help have been crucial throughout the process of this study.

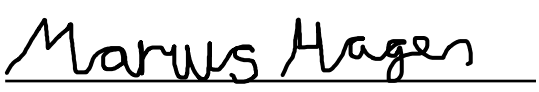
We would also like to extend our gratitude to the other groups in the DIG project who have contributed valuable insight through intriguing discussions, and our respondents who offered their valuable time to participate in our study. Our key contact at Telenor has been extremely helpful and introduced us to the rest of the participants.

We hope the thesis proves an interesting read and that it provides captivating insight into the exciting and evolving literature on emergence — and development of digital ecosystems.

Bergen, June 2020

Herman Melbye

Marius Hagen



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1. INTRODUCTION

1.1 Background and problem statement

Throughout the modern industrial era, corporations have been organized as traditional value chains which build on a linear approach to business. Control of the value chain has increased a corporation's market power, and this has allowed corporations to reap the benefits of economies of scale. However, things began to change as a consequence of the digital transformation of both society and business. Digital adoption has facilitated new ways of value creation and highly complex structures appeared. Empirical data show that traditional ways of organizing value creation are now of limited practicality when facing new complex problems. These complex problems usually involve demographic changes, capacity problems or climate change in a rapidly changing environment and require high investment costs, many independent actors, and different technologies. Additionally, the problems are too vast for one actor to deal with in isolation. However, as digital technologies continue developing, they start enabling new ways of creating value. Thus, a transition from traditional value chains to ecosystems occurs. This in turn facilitates a new type of enterprise, such as Apple and Amazon. These enterprises rely on the strength of their ecosystem to gain market power. Following this development, both public and private organizations have adapted ecosystem thinking and working in networks.

Ecosystem literature has focused on working in networks to create a complex value proposition drawing on an analogy to biological ecosystems, in which every species is important for overall survival. Following digital development, ecosystem literature has experienced an increasing focus on digital ecosystems. The mechanisms of ecosystems are well researched in literature and creates a foundation for the mechanisms of a digital ecosystem. Digital aspects of interaction and communication constitute the biggest differences. However, the literature is limited regarding the emergence of ecosystems and digital ecosystems. There is little research that shows how characteristics such as architecture and governance start to develop, and further evolve on the road to becoming a full digital ecosystem. Moore (1993) has published the only well-known and widely used framework for assessing the life cycle and development of an ecosystem. However, his work rests on the assumption that the ecosystem already is in existence and does not elaborate on what

factors need to be in place throughout the embryonic stage. Additionally, no similar frameworks assess how the characteristics of digital ecosystems are expected to evolve.

Ecosystem theory does not match the pace of empirical findings. This study will focus on the emergence of digital ecosystems and how key characteristics can develop. We wish to contribute novel theoretical— and empirical insights on these characteristics and how they are expected to change through the emergence and development towards a more mature stage. Additionally, we find critique with existing literature on life cycle theory and seek to extend this theory. This has resulted in the following research question:

What factors need to be in place for the emergence of a digital ecosystem and how can the key mechanisms evolve?

In order to answer this question, we perform a single case study of the multinational telecommunications company, Telenor, and their initiative to provide welfare technology in the Norwegian county, Agder. Welfare technology is defined as technical assistance that contributes to increased safety, social participation, mobility, physical culture activity, and strengthens the individual's ability to depend on themselves despite illnesses, and social-, psychological or physical disability (NOU 2011: 11, 2011, p. 99). The Norwegian government has a high interest in the implementation of welfare technology and has stated that an ecosystem is needed. It follows a complex problem in which the number of elderly citizens is rising, while the amount of hospital- and institutional beds are expected to be stable. Additionally, Norway has a fragmented municipal structure which makes it hard to coordinate among municipalities. For the last thirty years, this fragmented structure has created a diverse portfolio of inadequate systems and previous initiatives have resulted in little success. The problem demands solutions with a high degree of innovation, collaborative efforts through close interaction and many competencies across geographical areas and systems. All of these solutions must meet the requirements for data safety within healthcare. This requires a higher degree of coordination than traditional markets provide, and a more loosely connected network than traditional hierarchical structures accommodate.

The municipalities of Agder have managed to coordinate their efforts towards welfare technology and created a public tender, which ensures a joint procurement and uniformity. Telenor is now the full-service provider and has developed an Internet of Things (IoT) -platform, Shepherd, which

enables suppliers of welfare technology to connect and form an integrated part of a complete solution. Therefore, Telenor works as a hub, providing a baseline architecture, governing the interdependencies, and connecting the technological solutions. Throughout our study, we will refer to the ecosystem as the Welfare Technology Ecosystem. In this phase, it is pertinent to understand that it cannot yet be characterized as an ecosystem or digital ecosystem. However, we use these terms to highlight what is occurring at the emergent stage that Telenor and Agder are currently in.

1.2 Limitations

After reviewing internal documents from Telenor, actors' websites and the first round of interviews we determined the case's boundaries. The case is limited to how Telenor's product and service portfolio within welfare technology is used in Agder. By only looking at deliveries to Agder there are several customers of Telenor and welfare technology solutions that are excluded. Thus, the geographical boundaries are clear but there might be other ways to determine whether what is going on in Agder can be characterized as an ecosystem or just a part of a bigger ecosystem including all the actors that are connected to Telenor's solutions. Furthermore, it is important to mention that the municipalities are the paying customers and not the end-users. Therefore, the user aspect is of less importance for our paper, and we are mainly focusing on the municipalities that contribute directly to the ecosystem.

Our data is limited to include information about an early phase and what the respondents think will happen within the next 5 years. Additionally, the thesis is based on an on-going emergence of an ecosystem. As a result, we will have solid insight regarding today's situation. However, regarding the future of the ecosystem things are expected to change and our and the respondents' assumptions can quickly evolve as a consequence of change. Despite this we interview key people with crucial insight and the case is highly influenced by governmental plans and regulations. Following the extent and timeline of such plans, the results of our thesis is expected to be credible.

We have focused our interviews on the key actor, Telenor, one customer, one expert and one leader from the Directorate of eHealth. As we try to understand the ecosystem as a whole and how it is expected to develop, it would be interesting to get insight from other actors with a more peripheral involvement or the suppliers Telenor uses. However, due to limited time and scope, this would

have been too comprehensive. Despite this, the interviews and internal and public documents will give us important and in-depth insight that enable us to answer the research question.

1.3 Outline

The thesis consists of six chapters. After the introduction, we will present the literature review and relevant theory for our research question. In chapter three, we present our methodological choices regarding the research strategy, data collection and analysis. Here, we also present the strengths and weaknesses of our choices and show how we have overcome those obstacles. Furthermore, we present the empirical findings based on secondary and primary data in chapter four. These findings will be discussed in chapter five and tested against literature from chapter two. Lastly, a conclusion is presented in chapter 6, in which we will answer the study's research question. The conclusion also provides an overview of implications related to our study and interesting topics for future research.

2. LITERATURE

In this chapter we will review existing research on ecosystems and digital ecosystems. The first section reviews different definitions of an ecosystem and systemizes these. We build on these definitions to review the characteristics of the digital ecosystem. Here, we also present a working definition of digital ecosystems, which we will use through this study. Furthermore, we will review research on some important mechanisms of ecosystems and digital ecosystems. These are expected to evolve through the emergence of ecosystems and the birth phase towards a more stable phase. We further emphasize an early contribution which discusses the challenges ecosystems experience through its life cycle. The purpose of this chapter is to understand which mechanisms must be in place for the definition of a digital ecosystem to be satisfied, and to understand what is expected to develop through the emergence and further development of a digital ecosystem. This constitutes the guiding principles for what we seek to assess in our analysis. Again, it is critical to highlight that our thesis emphasizes the digital ecosystem. We use both the ecosystem and the digital ecosystem frequently because the ecosystem creates the basis for the digital ecosystem. The characteristic which distinguishes them is the latter's focus on the digital dimension.

2.1 A biological analogy

In 1993, a researcher named James F. Moore introduced the term business ecosystem to the field of strategy and business (Bogers, Sims and West, 2019). He used an analogy to biological ecosystems when explaining the business ecosystem. According to the United Nations (1992) a biological ecosystem is "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (p. 3). This definition implies that there are several interacting species that make the system effective and sustainable. Each species and organism also depend on the *non-living environment* such as oxygen and soil. Boley and Chang (2007) suggest a similar definition whilst expanding it to consider each species' self-interest. Their research article defines an ecosystem as *"*a loosely coupled, domain clustered environment inhabited by species, each proactive and responsive regarding its own benefit while conserving the environment*"* (p. 1). The motive for a species to participate in an ecosystem can be survival. For the ecosystem to be functional, the authors also state that in the absence of one species, the system can collapse. This analogy is an effective tool to understand and illustrate what

a business ecosystem is, but it is not without flaws. In a biological ecosystem, inputs such as sunlight or nutrients can be quite constant or follow predictable cycles (Iansiti and Levien, 2004). In business ecosystems, inputs such as technology and regulations constantly change. The authors also argue that regulators do not necessarily have a direct impact. Regulators affect guidelines for ecosystem actors such as how to interact and how to deliver value. This means that the indirect effect of regulatory institutions can be just as powerful as the direct impact of sunlight.

2.2 The business ecosystem

Using the biological analogy, Moore (1993) analyzed the problems managers experience regarding complex business communities that bring forth new innovations, constantly changing environments, and challenges related to cooperative and competitive interplay between different actors. He created the foundation for ecosystem thinking; rather than viewing the company as a part of a single industry, it should be viewed as being part of an ecosystem that crosses several industries. He illustrated this concept by studying the 1992 version of Apple and their ecosystem connecting actors across the markets of personal computers, consumer electronics, and information- and communications technology. Since Moore coined the term business ecosystem in 1993, more than 300 academic articles exploring ecosystems have been published in top journals (Bogers et al., 2019). Most publications were written in the past five to six years. However, academia has no clear consensus regarding the definition of a business ecosystem. Consequently, we will review several research papers regarding the business ecosystem and attempt to pinpoint the key mechanisms of ecosystems.

Characteristics of the biological ecosystem can be applied to the business ecosystem. Just as we have seen with biological ecosystems, Iansiti and Levien (2004) finds that a business ecosystem is characterized by "a large number of loosely interconnected participants that depend on one another for their effectiveness and survival" (p. 5). Such early contributions focus on the community aspect and how different actors in the ecosystem affect and depend on each other (Jacobides, Cennamo and Gawer, 2018). Adner (2017) has systemized these definitions. The research of Moore and Iansiti and Levien is systemized by using the term ecosystem-as-affiliation and sees ecosystems as "communities of associated actors defined by their networks and platform affiliations" (Adner, 2017, p. 40). Ecosystem-as-affiliation emphasizes the symbiotic relationships between actors in

the ecosystem and whether they are open and easily accessible. Crucial to these definitions is the existence of a keystone actor, also called a focal firm or hub. The keystone provides a common set of assets in the ecosystem (Iansiti and Levien, 2004). Usually this is done by creating a platform in which actors can interact. Simultaneously, the keystone must balance the value it captures for itself and the value that is offered to attract and maintain other members. Here, the ecosystem literature tends to focus on increasing the number of actors that are linked to the keystone or a platform provided by this actor. Looking at ecosystems such as the ones surrounding Apple and Wal-Mart, Adner (2017) finds that by connecting more actors to the focal firm, centrality and power will increase. However, Adner (2017) and Moore (1993) find that new interactions and a central actor guiding the ecosystem can increase the overall value creation and focus the efforts in the same direction.

By using the ecosystem-as-affiliation view, Adner (2017) stresses the challenge of disentangling the ecosystem's characteristics from other approaches, such as networks and multisided markets. However, this research fails to thoroughly consider the ecosystem's value proposition. Therefore, he provides a second view called ecosystem-as-structure, which sees ecosystems as "configurations of activity defined by a value proposition" (Adner, 2017, p. 40). Ecosystem-as-structure focuses on the value proposition which will be delivered and seeks to identify the actors that must interact for it to be realized. He offers the following definition: "...the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2016, p. 42). This definition expands the ecosystem to encompass more than interdependencies in communities and emphasizes the value proposition of the ecosystem. According to his research, the actors depend on each other and enter the ecosystem freely to contribute to the value proposition due to increased possibility of growth and survival. Breaking down the definition there are four central terms; *alignment structure*, *multilateral*, *set of partners* and *for a focal value proposition to materialize*.

The *alignment structure* discusses the extent to which there is some sort of mutual adjustment between the different actors and their positions and activity flows (Adner, 2017). The researcher stresses that each actor can have different objectives which creates an important distinction between participation and alignment. This alignment happens through *multilateral* interdependencies. In an ecosystem, a relationship between actors will not only be bilateral. An

ecosystem's *value proposition* will typically be more complex to understand than what can be explained by identifying and analyzing bilateral relationships. Interdependencies occur between a set of partners which through a joint value creation contributes to the ecosystem's general goal. Lastly, Adner (2017) finds that ecosystems focus on the actors' contribution to the *focal value proposition*, rather than the individual company and their goals.

Compared to the work of Iansiti and Levien and Adner, Jacobides et al. (2018) moves beyond explaining the definition of an ecosystem and focuses on the mechanisms behind the emergence of ecosystems. They define an ecosystem as a "set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" (Jacobides et al., 2018, p. 2264). Breaking down this definition, it is important to look at the mechanisms regarding "multilateral, non-generic complementarities". Ecosystems coordinate the "set of actors" which are interrelated. Coordination occurs in a way that delivers complementarities to the customer or user. Jacobides et al. focus on unique- and supermodular complementarities. Unique complementarities can go one or both ways; 1) one-way is when activity- or component A requires a specific activity- or component B, but B does not require A, and 2) two-way where A and B require each other. Essentially, by using A and B in combination it will serve the ecosystem's value proposition. The other type of complementarity in focus, supermodular, says that A and B are two different activities or components where an increase in A increases B's value. Doing more of one of them will increase the value of doing more of the other. Compared to the ecosystem of iOS, Apple's operating system, a unique complementarity is that an app will not work without the operative system, and the supermodular complementarity may be that the presence of an app increases the value of the operating system. We find it suitable to criticize this focus on complementarities. Scholars have looked at the presence and interplay of complementarities (Jacobides et al., 2018; Thomas and Autio, 2020). They have not focused on how a leader can enable complementarities or other ways this might occur. Lastly, Jacobides et al. (2018) says that the ecosystem is "not fully hierarchically controlled". It means that each ecosystem actor keeps control over their assets. Nevertheless, there may be a keystone controlling the standards and interfaces.

The last and most recent definition we review is written by Bogers et al. (2019), and states that an ecosystem is an "interdependent network of self-interested actors jointly creating value" (p. 4).

Interdependent, *network*, *self-interested actors* and *jointly creating value* are elements which several of the other ecosystem definitions touch upon. Therefore, the authors provide this definition of a broader character compared to Adner (2017) and Jacobides et al. (2018) which in turn can create insight surrounding ecosystems at a wider range. "Jointly creating value" is according to Bogers et al. (2019) and Adner (2006) the most common criteria for success when it comes to ecosystems. This value is created through interdependencies and the results depend on whether actors' goals are competing or complementary. Although there might be differences, actors depend on the ecosystem to realize their business model. Adner (2006) writes that the most common reason to join an ecosystem is to create value with others that an individual actor would not be able to do in isolation. Here we also see the previously mentioned self-interest of actors. Despite contributing to the overall success of the ecosystem, actors must expect that self-interest will triumph over other motivating factors (Bogers et al., 2019).

The ecosystem definitions focus on different mechanisms and are summarized in Table 1. This insight will be used as a basis in assessing what a digital ecosystem is. Also, several authors do not distinguish between the business ecosystem and the digital ecosystem. Additionally, we use it to create a solid understanding of which mechanisms that are likely to be in place for the emergence and development of a digital ecosystem. This allows us to structure our analysis.

Research and year	Elements from the definition
Moore (1993) **Iansiti and Levien (2004)** **Adner (2017) with "ecosystem as affiliation"**	• Community aspect • Interdependent actors • Keystone actor of great importance • Centralization
Adner (2017) with "ecosystem as structure".	• Focus on the value proposition • Interdependent actors • Self-interest • An open system
Jacobides et al. (2018)	• Non hierarchically controlled • Ecosystems coordinate to enable complementarities • Complementarity is an incentive for cooperation • Interdependent actors
Bogers et al. (2019)	• Jointly created value • Self-interest • Interdependent actors • Actors depend on the ecosystem

Table 1: an overview of ecosystem characteristics.

2.3 Digital ecosystems

Closely linked to the business ecosystem, digital ecosystem research has evolved (see appendix H for our definition on digitalization). The elements from the definitions in Table 1 create a foundation for what digital ecosystems are. The concept of digital business ecosystems emerged in 2002 by adding "digital" in front of Moore's "business ecosystem" (Nachira, Dini and Nicolai, 2007). It was first during a research project formed by the European Union (2007) that the word "digital ecosystem" was used as a coevolution between the business ecosystem and its partial digital representation. It is described as "the technical infrastructure, based on a Peer-to-Peer distributed software technology that transports, finds, and connects services and information over internet links enabling networked transactions, and the distribution of all the digital 'objects' present within the infrastructure" (Nachira et al., 2007, p. 5). This definition describes the digital ecosystem as a self-ruling mechanism that is driven by members' capability to interact.

Furthermore, Boley and Chang (2007) defines a digital ecosystem as "an open, loosely coupled domain clustered, demand-driven, self-organising agent environment, where each agent of each species is proactive and responsive regarding its own benefit/profit but is also responsible to its system" (p. 53). According to the authors, this defines a digital ecosystem as a virtual environment enabled through the usage of digital technology. Being an open environment refers to an open and freely entered community. "Loosely coupled domain clustered" means that there are no predefined roles and interdependencies, and that these will evolve. Moreover, there is no permanent need for centralised or distributed control or for single role behavior. Hence, it is an open community in which a leadership structure can be created and dissolved depending on how the environment and demand change. More recently, Jacobides (2019) builds on this definition and defines digital ecosystems as "interacting organizations that are digitally connected and enabled by modularity and are not managed by a hierarchical authority" (p. 1). This definition emphasizes the importance of digital connectivity and modularity, which ensures that new actors can add value.

Another author, Valdez-De-Leon (2019), modifies Jacobides definition by defining the digital ecosystem as "loose networks of interacting organisations that are digitally connected and enabled by modularity, and that affect and are affected by each other's offerings" (p. 44). Valdez-De-Leon uses elements from Jacobides' research but emphasizes how the members influence each other's behaviour. He also points out that digital ecosystems outcompete the traditional integrated value

chains regarding cost. This is because efficient digital technology can eliminate the transaction costs between two independent parties. This mainly occurs through the adoption of "buying" not "making" mentality.

Furthermore, Iansiti and Lakhani (2017) point out three different elements in the technological developments that can explain the emergence of digital ecosystems. The first element is the rapid development of significantly higher processor power in the last decade. This has led to a notable increase in the capabilities companies have to digitalize and develop software with higher capacity. The second element is the actors' increased possibilities to communicate efficiently within interconnected networks. This has made communication both cheaper and easier than before. The improvement of communication systems has also made it easier for independent actors to connect to a network, which ultimately has resulted in lower barriers to entry. The third and final element is about how digital networks add value through feedback channels (Iansiti & Lakhani, 2017). Alongside the flow of data through digital systems, the organizations are able to interact with their users, and use their feedback to improve their systems (Weill & Woerner, 2015).

When research emphasizes digital technology, the mentioning of platforms and digital interfaces occurs. These are highly specific solutions and every sector demands a specific type of design based on regulations, competitive characteristics and the specific services that are offered. However, it is possible to identify some general characteristics surrounding the architecture of digital ecosystems. According to Tiwana (2013), the digital ecosystem is the collection of platforms and the software and applications specific to it. This is closely intertwined with the research of Parker, Van Alstyne and Choudary (2016) which states that the platform is the rules and the architecture that facilitates interactions among the actors of a digital ecosystem. The architecture then becomes a part of the governance model enabling other actors to join. Tiwana (2013) finds this to be an important part of coordination and can enable complementarity.

From our review on the business ecosystem and the digital ecosystem, we found that the keystone, complementarity, interdependent actors, and non-hierarchical control are key characteristics that are repeatedly discussed in existing literature. The main difference is the effect of digital technology and how this can coordinate the efforts of different actors and enable a modular architecture. Here, we have combinated explicit research on digital ecosystems with more technical research by Tiwana (2013) and generated a deeper insight on how the digital aspect

works. Architecture and governance are intertwined. By reviewing literature with an explicit focus on digital ecosystems we highlight the fact that there is limited focus on standardization and digital interfaces. In our study we therefore choose to modify Valdez-De-Leon's definition of the digital ecosystem and add an element stating that the coordination happens through a standardized digital interface; *Digital ecosystems are loose networks of interacting organisations that are digitally connected and enabled by modularity. The coordination of actors' efforts occurs through the standardization of digital interfaces that affect and are affected by each other's offerings.*

2.4 Modular architecture

When reviewing the literature, it is evident that architecture is vital and that a modular architecture is a key characteristic of the digital ecosystem. Jacobides et al. (2018) describes modularity or modular architecture as a characteristic that enables coordination of interrelated actors with significant autonomy. Every actor is allowed to realize their goals and business models and the modular architecture coordinates this in the direction of the ecosystem's value proposition. Typically, one will find a keystone actor responsible for the modular architecture by maintaining the rules of engagement. Alignment occurs through rules of engagement, standards, and interfaces. Each actor must adapt and follow these rules but will typically be free to achieve one's own objectives. The authors promote modularity as an important characteristic for emergence of ecosystems, but state that it is not sufficient alone. Additionally, there must be a need for coordination that cannot be solved through traditional markets. It is also important to highlight that modularity does not necessarily create a free to enter- or plug and play ecosystem. In some parts, this might be the case, but in most parts of the architecture there are conditions of participation and a degree of exclusivity (Jacobides, 2018).

According to Baldwin (2012), modularity is a characteristic that creates a solid basis for innovation. When a modular architecture is in place, it is possible to experiment with the modules and the architecture as a whole without compromising the whole ecosystem. It creates a system where heterogeneous actors with autonomy can innovate collaboratively. If the organization was operating alone, it is plausible that issues related to governance and coordination would limit innovation. For the actors of the ecosystem, there is still competition to provide the best solutions and actors might be outcompeted and new actors enter. It is important to understand that this is

most likely to be the case but even when firms compete, the ecosystem at large will evolve and new combinations within the modular architecture are created. The presence of modularity first took place within high-tech industries in which information is key. This practice has currently spread to other industries parallel to the increased degree of digitalization in society.

2.5 Governance

Governance in ecosystems includes the activities related to establishing the ecosystem and involving actors, rules for participation, and how to coordinate this to retain interest (Jacobides et al., 2018). Jacobides (2019) describes digital ecosystems as systems based on open source solutions that are not governed by a hierarchical authority. The non-hierarchical structure is a recurring characteristic in ecosystem literature. Despite this factor, there is still a need for some level of control or coordination. Bogers et al. (2019) find that governance is expected to be characterized by a combination of different mechanisms balancing control and coordination.

Jacobides et al. (2018) find that the leader or hub often is important when it comes to governance. Many ecosystems emerge where coordination problems are rife. A need for leadership to ensure coordination across the set of heterogeneous actors and interdependencies is therefore important. A leader therefore uses tools to control, motivate and coordinate the efforts, even though the ecosystem theory states that it is characterized by a high degree of autonomy (Jacobides et al. 2018). Some examples are standards, interfaces and rules for participation. Compared to more traditional ways of doing business, such as value chains, the leader creates a basis for others to work within. The leader does not unilaterally decide factors such as price and quantity. By maintaining this foundation of standards, interfaces and rules Moore (1993) finds that the leader executes an important monitoring role. The ecosystem must be aware of its surroundings such as other competing ecosystems or emerging ecosystems. Other actors depend on this leader role for their own survival and success.

Moore (1993) also finds that the governance structure is expected to evolve over time. As we present in Section 2.7, his focus is on life cycle theory and states that an ecosystem will evolve from a random collection of elements to a structured community. This also accounts for governance. In an early phase, the focus will be on cooperation and the leader must have a flexible approach to involving other actors. In a more established phase, the system becomes firmer and

the degree of standardization is expected to increase. Now the leader will have the role of maintaining the standards and interfaces. Standardization allows the different actors and complementors to be coordinated without using hierarchical control (Jacobides et al. 2018). This is closely intertwined with the concept of modularity. By working within the basis every actor is allowed to control their own module while producing the ecosystem's mutually dependent products and services. Modularity displaces the need for formal contracts between actors.

Bogers et al. (2019) also emphasizes the more informal types of governance such as social governance, self-regulation and trust. Darking (2007) finds that governance characterized by informal mechanisms is expected to create a higher degree of flexibility. When the degree of centralization is low, the ecosystem is capable of responding to changes faster and adapting to the customer demand. Elements such as trust can facilitate knowledge sharing and engagement between actors occur through open source development. To make this possible, it is important to focus on data safety. With constantly evolving regulations, governance in digital ecosystems must make technological solutions which ensure security and prevent actors from misusing the ecosystem and its data (Darking, 2007). The infrastructure must be trusted, and data must be able to be shared in a safe manner. This will also be possible through self-regulating mechanisms such as trust (Radziwon and Bogers, 2019). Actor A, B and C will typically be mutually dependent on each other and A knows that its actions inflicting damage to B or C will damage the relationship. Hence, trust is affected negatively. Additionally, the ecosystem's overall success is damaged. This means that self-regulating mechanisms prevent unwanted behavior and the usage of formal contracts is less necessary.

The extent to which actors can affect the tools and rule-setting, or if the focus is on informal agreements, varies across ecosystems. Jacobides et al. (2018) finds that some ecosystems need to be strictly controlled according to regulations and guidance from public institutions. Others can have a more open policy in which everyone can connect through a modular infrastructure. It is important to state that these are two extremes and most ecosystem governance is expected to be a combination (Bogers et al., 2019). As mentioned by Moore (1993), this is also expected to evolve. According to Jacobides et al. (2018), this is a topic with little existing research.

2.6 Roles in an ecosystem

Through the review of ecosystem literature, we find that the leadership role is central. Iansiti and Levien (2004) mention hub and keystone which is looked upon as the provider of stability. It is common for the leader to provide a common set of assets. Jacobides et al. (2018) states that the leader is most often responsible for maintaining the architecture and creates the foundation for modularity. In the context of platform ecosystem, Cusumano and Gawer (2002) mention the leader as the platform leader. Typically, this is the owner of the platform and main integrator of value in the ecosystem. Additionally, it controls critical resources and maintains the governance structure. The platform leader decides which actors that can participate and what they are allowed to do. Bogers et al. (2019) criticizes this role and finds that ecosystem leaders focus on their own success, rather than monitoring the other members efforts to increase the success of the ecosystem.

Furthermore Dedehayir, Mäkinen and Ortt (2018) focus on direct value creation roles. By reviewing literature (Adner 2006; Dedehayir et al. 2018; Jacobides et al. 2018) we find complementors to be repeated. These actors attain compatibility with the platform and meet customer demand. Different actors can have this role. Relevant to our thesis is the role of suppliers as a key component of the ecosystem's value proposition. According to Iansiti and Levien (2004) these roles are complementors that follow the rules set by the leader and focus on delivering a special part of the solution.

Drawing on the biological analogy, institutions such as universities and other non-profit organizations can be compared to the elements of soil and oxygen. Dedehayir et al. (2018) describes it as value creation support in which the actors generate knowledge, provide consultation and encourage technology transfer and commercialization. Bogers et al. (2019) placed universities in this category and finds that these actors promote innovation and a shorter route to commercialization, hence increasing the likelihood of the ecosystem's survival. The same logic is found for standard-setting roles. They depend on the ecosystem for their own survival. Simultaneously, they create a common ground for the active participants to coordinate their technological processes. By creating standards, they contribute in coordinating competitive and cooperative organizations and make it easier for the ecosystem to be aligned with government regulations.

Furthermore, Dedehayir et al. (2018) emphasize the entrepreneurial roles in an ecosystem. The entrepreneurs start new ventures by co-locating in regions where other relevant actors are present and contribute to the coordination of research and commercialization partners. Other scholars such as Jacobides et al. (2018) focus on the innovative characteristics of ecosystems and how entrepreneurial actions contribute to the development of the ecosystem. Dedehayir et al. (2018) also emphasize the actors supporting the ecosystem and innovative manners and place them in the same category. For an ecosystem to emerge, regulators provide economic and political landscapes to develop within and provide regulatory restrictions.

2.7 The lifecycle of an ecosystem

So far, we have reviewed important characteristics of ecosystems and digital ecosystems. The previously mentioned first contribution to ecosystem literature provides a life cycle framework (Moore, 1993). He describes birth, expansion, leadership and self-renewal as four evolutionary stages that characterize the development of the business ecosystem. A company moves through these four stages from operating independently to operating in networks of organizations that aim to deliver holistic product or service value to the end-user. The previously highlighted characteristics are expected to evolve through these phases and challenges regarding collaboration and cooperation arise along the four phases. Here, it is important to state that this framework originally was developed before research on digital ecosystems. However, it is found to be the most profound framework for assessing the life cycle. Since the characteristics of the digital ecosystem are found to be similar to the business ecosystem, we use this framework to assess how limited research is regarding the embryonic stage, emergence and development of digital ecosystems.

In the first phase, referred to as the birth of the ecosystem, the products and services must be well understood by all the members of the ecosystem (Dedehayir & Seppänen, 2015). The common understanding secures collaboration and directs the ecosystem towards the same objective. Here it is important to work with customers and suppliers in order to collectively define a new value proposition. When it comes to competition, it is important to prevent different actors from imitating each other's business ideas. A common response to the threat from the keystone actor is to take a leader position to ensure cooperation between key organizations which will provide

complementaries and establish strong ties to customers and important channels (Moore, 1993). According to Jacobides et al. (2018) these deliberate actions are important for the emergence of ecosystems. Moore's life cycle theory assumes that the establishment of the business ecosystem is given and that the products and services already are in place. The theoretical framework's application is therefore limited and does not describe what needs to be in place before the birth phase or how the earliest contributions attract and include the actors. In our thesis, we build upon Moore's life cycle theory but expand his framework by analyzing what mechanisms must be in place for the birth phase to begin.

In the second phase, the ecosystem expands into new territories of application. In this phase, rivalries eventuate as the same markets become occupied by other ecosystems. The most collaborative ecosystem with actors that apply their expertise in complementarities, such as distribution and marketing tend to win. It is therefore key that the keystone succeeds in establishing strong relationships between the customers and suppliers (Moore, 1993). In terms of challenges, the ecosystem needs to ensure that it approaches the market's standard through dominating key market segments as well as eliminating competition from other implementations with similar ideas. Moore (1993) makes the assumption that there is a fully developed infrastructure allowing the keystone to undertake this process and expand. However, he does not discuss how this is developed and what must be in place for it to develop. Following the digital element of the research question, we adjust the framework and enhance the focus on technological architecture and how the governance model can evolve accordingly. This follows the distinctions we found by reviewing literature on both business ecosystems and digital ecosystems.

The third phase of the life cycle, leadership, diminishes the ecosystem's dependence on the keystone (Moore, 1993). The architecture evolves towards a stable state and the actors have an increased focus on standards, interfaces, modularity and customer relationships. Here, the aim is for every actor, whether it is a complementor or keystone, to maintain a high degree of power to ensure a strong position within the ecosystem. Complementors do this by expanding their business to the closest part of the value chain. Thus, they are able to create stronger competition between ecosystem actors. This is allowed by a stable modular architecture in which the modules become evident. The keystone attempts to establish strong relationships with complementors and

customers. By establishing these positions, it is important for the actors to promote working towards improving the value proposition.

The final phase of the life cycle is renewal or death. The path that follows the destiny of the ecosystem is decided by its capability to encounter new regulations and change in customer needs, its ability to innovate and face competition from other ecosystems and respond to alterations in the environment (Moore, 1993). In order to survive, it is essential that the ecosystem renew itself. For instance, this objective can be achieved through cooperation with new and innovative actors. In this period, it is extremely important to maintain high barriers of entry for alternative ecosystems. This can be attained through maintaining high customer switching costs to buy time and incorporate new innovative ideas. Ecosystems are likely to be part of several phases and contain elements from each phase. This is especially true when it comes to digital ecosystems. This framework was created in a more stable business environment in which traditional value chains dominated a market. Today, change is rapid and digital technology enables businesses to quickly create new solutions and compete with existing ecosystems. Therefore, we adapt this framework by stating that the phases are more susceptible to fluctuations.

2.8 A theoretical framework

Building on the literature review, we will now summarize this insight and foreshadow its use in our research. This ensures that the reader understands that we explore the digital ecosystem with the basis necessary for assessing the concept. For something to be characterized as a digital ecosystem and to take advantage of it, literature shows that there must be a need for several types of actors that fill important ecosystem roles. We especially highlight the keystone, complementors, value creation support and entrepreneurial roles. The keystone is responsible for providing common resources. According to the digital dimension, a standardized digital interface often appears as a platform which enables other actors to contribute. This constitutes an architecture and governance model as key characteristics of digital ecosystems. Furthermore, their construction will set the terms for how the coordination of different actors' efforts will be and if the digital ecosystem manages to provide complementarities. When traditional ecosystems become more stable and result in profit that is evident to the public, life cycle theory shows that competition increases. In the era of digital technology, this might occur at an early phase and other ecosystems

can quickly replicate solutions and innovate on these. We use theory on these characteristics as a basis for our analysis and to create structure throughout our study.

3. METHODOLOGY

In this section, we provide an overview of the research method and explain how the empirical part of this study has been performed. We will present choice of research methods, data collection, and analysis. This section is followed by a discussion regarding potential threats towards the validity and reliability of this study. Finally, we will highlight ethical issues surrounding our research.

3.1 Formal organization

The study has been a part of Digital Innovation for Growth (DIG). It is a national research center that will focus on various aspects of digital innovations for sustainable growth. NHH, NTNU, and Telenor have formed the center together. By being part of DIG our focus has been to gain insight on the emergence of digital ecosystems. During the first half of the semester, there were two professors and four groups of researchers performing joint discussions of what digital ecosystems are and how they emerge. The groups and professors established a common understanding of ecosystems and digital ecosystems, as well as assigning the groups with cases. Additionally, we developed a common interview guide. However, this has later been modified. The cases that were offered are developed by Telenor, and we decided to work on the topic of eHealth. Within this topic, Telenor offered us to choose between three cases. Since we are limited by the time, we chose to focus on one case. The case in focus is the most developed and commercialized of the three. We believe that this will create the strongest foundation for addressing the thesis' research question.

3.2 Research design

The research design is the deliberate plan on how the research question will be answered and has implications for the research process (Saunders, Lewis & Thornhill, 2019). According to Saunders et al. (2019), there are three designs of academic studies; 1) descriptive, 2) exploratory and 3) explanatory. Since our study aims to understand *what factors need to be in place for the emergence of a digital ecosystem and how the key mechanisms can evolve,* and this is a subject with limited previous research, the thesis is based on an exploratory design. The exploratory design is particularly useful when the study aims to uncover a problem, issue, or phenomenon (Saunders et al., 2019).

The next step is to decide whether one follows a quantitative, qualitative or mixed methods research design (Saunders et al., 2019). Quantitative research is a data analysis procedure that generates numerical data while qualitative research uses non-numerical data. Our research question is open-ended, and it is, therefore, unsuited to be answered by numerical data. Due to the explorative nature of our research question, we have chosen a qualitative approach in our study. A qualitative method allows us to collect data in non-standardized manners. This increases the flexibility regarding the collection of data, which implies that we can have flexibility during the research process (Saunders et al., 2019).

Furthermore, the research strategy is a plan for how we are going to act to collect the data we need to answer the research question. According to Saunders et al. (2019), one of the main strategies of collecting data using a qualitative approach is case study.

3.2.1 Case study

A case study is a "research method, generally used to investigate a contemporary phenomenon in-depth and in its real-world context" (Yin, 2018, p. 286). By using a case study, we can gather thorough and detailed in-depth data which is crucial to answer the research question. A case study is also appropriate with our thesis' explorative purpose.

There are mainly two dimensions in the design of the case study (Yin et al., 2014). One of the dimensions is whether one works with a single case or a multi-case. The other dimension is decided by if one makes use of one or many units of analysis. Since we want to explore the topic of the embryonic stage of digital ecosystems in-depth, we focus on the healthcare sector and within the sector we limit or scope to what is happening in Agder. For our case, this means that we will look at three municipal projects and treat them as one constantly evolving process. Furthermore, Yin et al. (2014) point out that a single case study is used purposely because it provides the researcher with the possibility to observe and analyze a phenomenon that few have researched upon before. Since our research question directs us to observe how Telenor's healthcare platform, Shepherd, functions as an ecosystem, which is a yet undiscovered ground for research, we consider a single case study to be a good fit for our paper.

3.3 Research Approach

In this thesis, an inductive approach has been applied. An inductive approach means that we seek to build and generate a theory and that we are moving from the case's specific data and try to test this against existing literature (Saunders et al., 2019). Research with an inductive approach seeks to obtain in-depth knowledge of a particular case. Therefore, a small research sample is a better fit for our thesis than a large number as used in a deductive approach (Saunders et al., 2019). In the existing literature, research describing the process of emergence is nearly absent. Several scholars have looked at how ecosystems are characterized and some mention how key mechanisms evolve. Despite this, only one clear contribution to the ecosystem life cycle theory is found; Moore's Life Cycle Theory (1993). However, this theory is rather incomplete and does not consider the embryonic stage. We aim to contribute to this field of research by investigating the Welfare Technology Ecosystem and its emerging stage. Because of its complex and undiscovered characteristics, we consider an in-depth analysis through an inductive approach as the best fit for our master thesis. This allows us to explore the topic without being limited by existing research.

3.4 Time horizon

This study is a master's thesis and will be performed during the timeline of one semester. As a consequence, it will be a cross-sectional study where the interviews are carried out once. Our cross-sectional study involves studying the Welfare Technology Ecosystem through the spring of 2020 (Saunders et al., 2019). The concept of digital ecosystems is relatively new and is closely linked to digital technology and digitalization. Additionally, the Welfare Technology Ecosystem is constantly evolving and rapidly going through changes. Therefore, it is a risk that a cross-sectional study can lead to limited trust in our findings. Despite this, we believe that performing an explorative study through only one semester will be rewarding and the findings can be of great significance within the field of ecosystem emergence.

3.5 Data collection

We collected the primary data ourselves, while the secondary data were handed out by our contact person from Telenor and retrieved from the internet. The secondary data was utilized to obtain an overview of the case, while the primary data was mainly used to understand the mechanisms and

the road ahead. Our supervisors from the DIG project provided us with our contact person in Telenor. In the following section, we will present a more detailed description of the data, our samples, and the execution of interviews.

3.5.1 Secondary data

Secondary data can include text, visual media, and audio and are useful by giving additional meaning to the primary data and preparing for the research process (Saunders et al., 2019). Sources of secondary data in this study include documents that have been shared with us by our contact person from Telenor and multiple web pages owned by the ecosystem's actors. The contents of the internal documents are described in the table below.

Internal documents	Description of content
Internal document 1	Presentation slides with information about digital supervision, definitions, and daily operations.
Internal document 2	Introduction into one of the most important technologies within welfare technology.
Internal document 3	An overview of the different suppliers of welfare technology and how they are connected to the Shepherd platform.

Table 2: Description of documents.

The secondary data helped us develop our interview guide as well as it helped us to form a complete picture of the situation. Although our analysis mainly has been based on primary data, the secondary data supported us on how to ask the respondents about the context and what led to the establishment of the ecosystem.

3.5.2 Semi-structured interviews

After choosing between the three cases we received internal documents from Telenor. By reviewing these we soon found that the Welfare Technology Ecosystem is of a particularly complex art. Combining insight from internal documents, information from ecosystem actors' web pages, and existing literature on ecosystems, we were able to discover several topics that needed further investigation to create a complete overview of the ecosystem. Based on this insight and our inductive approach we found interviews to be the best fit for our thesis (Yin 2014). We chose to use semi-structured interviews consisting of a predefined list of questions. The predefined list of questions is important for keeping the structure in the interviews, as well as it ensures the flexibility

to customize questions to each respondent and to alter the order of questions through the execution if necessary (Saunders et al., 2019). This type of interview is often used in qualitative studies (Saunders et al., 2019). By using semi-structured interviews, we can connect the questions to the thesis' focus while still being able to openly investigate the issues our respondents promote. Our choice of interview form is also motivated by the belief that our knowledge and understanding will evolve through the research process.

3.5.3 Execution of interview

Due to the situation following Covid-19 every interview has been conducted by the usage of Zoom, 2Meet, or Skype to satisfy the requirement of social distancing imposed by the Norwegian government. Four out of five respondents had decision power in their organization and the fifth being a researcher and expert. There were two respondents from Telenor, one from an important customer of Telenor, one from the Directorate of eHealth, and one expert within healthcare and ecosystems. The duration of the interviews ranged between 45-60 minutes and the last follow up interview with Telenor lasted 25 minutes. Besides the last interview, we aimed at a duration of 40 minutes to ensure flexibility regarding the open-ended part of our semi-structured interviews. For the sake of anonymity, the table below gives an overview of the informants and affiliation but does not go into the position or description of each informant. We conducted seven interviews. Respondent 1 was our contact person in Telenor.

Respondent	Affiliation
Respondent 1 *(4 Interviews)*	Telenor Business Developer- Two interviews combined with the Telenor Leader and two alone
Respondent 2 *(2 Interviews)*	Telenor Leader- Two interviews combined with the Business Developer
Respondent 3	Welfare Technology Project Leader
Respondent 4	Leader Expert within Healthcare and Platforms
Respondent 5	Directorate of eHealth Leader

Table 3: Overview of informants.

The respondents possessed knowledge and experience from the healthcare sector and can be considered a more or less homogenous group. According to Kvale and Birkman (2015), five respondents is a sufficient number of respondents in qualitative methods. This is also enhanced by

the actors being homogenous in terms of industry knowledge and we can map every aspect of the ecosystem by talking to respondents from ecosystem actors which are expected to have different ambitions. Before the interviews, we sent interview guides to the respondents 1-2 days in advance. To create these, we mapped relevant literature on digital ecosystems by using Google Scholar and the institutional repository at NHH, Brage. Additionally, we continuously used Saunders et al. (2019) in the processes of collecting data. As shown in the Appendices A, B, C, D, E, F, and G there are some important differences between the interview guides.

The first round of interviews included one conversation with Telenor's senior business developer where we decided on the case and received some introductory information, one joint interview with the senior business developer and the leader of Telenor's department of eHealth, one interview with the respondent representing a customer, and one interview with the expert. The interview guide for the first joint interview with Telenor was developed by considering our discoveries regarding issues such as ecosystem actors, coordination and the platform technology from creating an overview of the ecosystem. Our aim was to investigate and uncover dependencies between issues related to the information from the internal documents and public information. Consequently, we were able to map the ecosystem and discover the emergence of it. We also asked the respondents who they would recommend us to talk to for further investigation. The respondents gave us contact information for one of Telenor's customers. This technique is often referred to as a snowball sampling technique and is suitable to use when members of the population are difficult to locate (Goodman, 1961). We kept to this technique in the recruitment of other participants in the interviews that followed. The first joint interview with Telenor, and the interview with the customer were used to create an overview of the Welfare Technology Ecosystem which helped us develop an interview guide for the expert. The expert gave us the contact information to the respondent from the Directorate of eHealth.

The second round of interviews included one joint interview with the two respondents from Telenor, one interview with a leader from the Directorate of eHealth, and one follow up interview with concluding remarks with our contact person from Telenor. Before developing these interview guides, we had started our analysis and development of a conceptual framework. Building on this we were able to scope the focus of the second round of interviews and dig deeper. Accordingly, the interview guides become more similar to the conceptual framework compared to the first

interview round. This strategy allowed us to have a clear but flexible structure from the beginning as well as the in-depth analysis of the interview helped us to further develop our framework. The table below provides an overview of the interview process and how the agenda for each interview gradually evolved as we obtained more information about the case.

Respondent	Week number and agenda
Respondent 1 *(4 Interviews)* **Respondent 2** *(2 Interviews)*	**Week 8:** Introduction to the Welfare Technology Ecosystem and planning. *Only respondent 1.* **Week 11:** First interview utilizing the first predefined list of question. This list was developed based on the existing literature and research, and we sought to get a better understanding on the embryonic stage of the ecosystem. *Respondent 1 & 2.* **Week 19:** Second interview utilizing the second predefined list of questions. This round's agenda was to obtain in-depth insight in the coordination mechanisms and the roles surrounding the ecosystem. *Respondent 1 & 2.* **Week 22:** Clarification round. Sought to sum up everything that had been unclear and that was lacking in our framework. *Only respondent 1.*
Respondent 3	**Week 15:** This interview's aim was to get insight from one of the initiators of the ecosystem and the incentives for establishing it.
Respondent 4	**Week 18:** Our aim was to get a deeper understanding of the healthcare sector, as well as how digital platforms can facilitate ecosystems and the mechanisms surrounding it.
Respondent 5	**Week 20:** The directorate of eHealth has been an important player for accelerating the Welfare Technology Ecosystem. Our aim was to better understand one of the most important actors in the ecosystem.

Table 4: Order and agenda of interviews.

When conducting the interviews, we were determined on encouraging the respondents to formulate personal experiences, feelings, and attitudes relevant to the research question. This follows our need to gain a deeper understanding of people's behavior and motives through a conversation where a vast array of feelings and ideas can be expressed. Furthermore, it was important to give the respondents an overview of the situation before they began to speak freely and answer our questions (Kvale and Birkmann, 2015). Thus, we introduced the interviews with a clear definition of digital ecosystems, our background, and the purpose of the interview. In our declaration of consent, the respondents also allowed us to make audio recordings. For safety, we asked them one more time before starting the interview.

3.6 Data analysis

In the following section, we present the process of preparing, coding, and analyzing the data. The interviews were transcribed, and quotes were translated into English as part of the data preparation.

The coding method applied in this study is template analysis. We present the results of the coding process in the findings section.

3.6.1 Preparation of data

After the interviews were conducted, we began the process of transcribing the data. The objective of the transcription is to facilitate an effective analysis of the data (Kvale and Brinkmann, 2015) According to Kvale and Brinkmann (2015) the transcription can be described as an interpretation process where the difference between spoken language and written texts can cause practical and principal problems. To avoid the presence of these problems, we conducted the transcription right after every interview. We decided that one of the researchers took the responsibility for transcribing all the interviews, to make the process more standardized. This made the system in the material more consistent. After conducting the transcription, we were confronted with a variety of protocols with text, one from each respondent. When all the interviews were transcribed, the researcher that had not conducted the transcription made notes from it. Thereafter, we carefully discussed the transcribed material together, to ensure that we did not miss anything crucial.

3.6.2 Template Analysis

Template Analysis has been applied for the analysis of the data. Template Analysis is a method of thematically organizing and analyzing qualitative data. In this type of analysis, the researchers only code a proportion of the data before developing an initial list of codes and themes (King, 2012). We started by coding a sufficient part of the transcripted data to create an initial coding template. The coding template is a hierarchical list of codes and themes and is used as a central tool of analysis in qualitative data (Saunders et al., 2019). Since some of the interviews were conducted weeks apart from the others, we based the initial list on the first interview. Further, we conducted and transcribed more interviews. The findings from these interviews were added and we modified our initial coding template until a final template was ready. The illustration below shows how the higher theme in our initial coding template evolved from being named “Ecosystem” to “Digital Ecosystem”. Additionally, we added suborder themes as the information became more specific. The suborders were determined on behalf of what characterization the code fitted into. A few more codes were added, and others were moved to a different, higher-order theme.

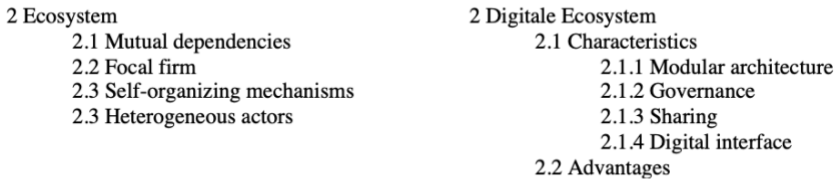

Figure 1: Development of the coding template.

This is an exploratory process involving the rearrangement of codes until they are categorized into themes that represent key relationships and ideas in the data (Saunders et al., 2019). We found this method to be most reliable because there is limited theory on the definition of the digital ecosystem and mostly the mechanisms that explain the embryonic stage. This is the reason why we used an explorative method. In this way, we could synthesize what we found interesting from the interview and link the material with other quotes that were coded in the same category. The final analysis work was conducted in Google Sheets. This tool was helpful regarding the Covid-19 situation and it allowed us to follow each other's progress without meeting physically.

3.6.3 Citations

To present some of the citations in the study, we had to customize them according to the text. Therefore, some places there will be « […] » in the middle of our quotes. This indicates that we have removed parts of our quotes. Furthermore, there are some written words in brackets. This means that we have either chosen to use a different word than the respondents used, without changing the meaning, or we have replaced a word to more properly explain the context. This is to not reveal any of the participants' names. We were able to do this since the concrete information about participants will not influence our research question. Finally, we have carefully translated all of the quotes into English to keep consistency within the text, without altering the information.

3.7 Assessment of the quality of the data material

In this section, the quality of the methodology and findings are evaluated. General quality for quantitative studies is based upon the four criteria reliability, validity, generalizability, and

objectivity. However, it is argued that these determinants are not suitable when addressing the designs and nature of qualitative studies (Sinkovics, Penz & Ghauri, 2008).

The most cited system of evaluating quality for qualitative research is developed by Lincoln and Guba (1985). Lincoln and Guba (1985) have developed four criteria for qualitative research. The researchers suggest that quality concerns should be focused on trustworthiness and encompass issues such as credibility, dependability, transferability, and confirmability (Lincoln and Guba, 1985; Sinkovics et al., 2008). *Credibility* is used instead of internal validity and refers to the "truth" in the findings, and that the participants' social constructed reality corresponds with what the participants meant. *Transferability* is the parallel to external validity and involves showing that the findings are applicable in other contexts, where the researchers must have a precise and complete description of, for example, research questions and interpretations. *Dependability* is about how to show that the findings are consistent and can be repeated, where the statement for all the changes along the study is important. *Confirmability* matches objectivity and is used to consider whether the researchers have influenced the results (Lincoln and Guba, 1985).

3.7.1 Credibility

Credibility is about ensuring that the understandings of the respondents match the findings presented by the researcher (Saunders et al., 2019; Sinkovics et al., 2008). Since the Welfare Technology Ecosystem is complex and involves many different actors, it was particularly important to take time and effort to obtain a complete sense of the context. To succeed with this, we had to use multiple data sources which according to Guba (1981) is important to ensure credibility. Throughout the study, we focused on obtaining a better understanding of welfare technology and Telenor's integration platform. After being selected to work with ecosystems and healthcare we performed a vast amount of research before our first meeting with our contact person in Telenor. He provided us with the three non-public documents presented in the section, *Secondary Data*, that we had to read carefully. These documents were important to develop an overview of the case study.

We approached every interview by encouraging the respondent to make use of follow-up questions and re-explain if something appears unclear. Regarding the nature of qualitative methods, an important way of ensuring credibility is to actively reword the questions to clear up any possible

misinterpretations immediately (Lincoln and Guba, 1985). We have also informed the respondents that they can contact us at any time if they have questions. As this is a master study, there is a limited amount of time we can spend to understand the context and build trust for our respondents. Hence, this is an aspect that may impair the credibility of our study.

To enhance the credibility, we used a technique called triangulation. Triangulation involves using multiple methods, data sources, observers, or theories to gain a more complete understanding of the phenomenon being studied (Patton, 1999). Among the four triangulation types that Patton (1999) has identified, we chose the triangulation of sources. This involves using different data sources within the same method. In our study, we have involved five respondents in which all of them have had unique experiences with the Welfare Technology Ecosystem. In this way, the respondents have confirmed each other´s history as well as provided us with different perspectives. The respondents we have selected are from an array of different organizations which has allowed us to investigate the case from a broader perspective. Furthermore, our combination of secondary and primary data has enabled us to cross-check the information from different sources. We have utilized a variety of different sources to increase the credibility of the study.

According to Lincoln and Guba (1985), participant validation is a method to establish credibility. Participation bias does mean to test the data, categories, and interpretations with the participant that the data originate from. We have been focused on testing our understanding of the participants during the interviews, where we have spent time asking follow-up questions. These questions have in many cases been used to establish a picture of the respondent's view on the future of the digital ecosystem. Here, we have been very clear on separating between what has been planned by Telenor and what are just general opinions. All our informants were people with high positions within welfare technology. Due to their busy schedule, they have not had time to check our transcribed material, which can impair the credibility of the study. However, this is not something one can expect when collecting data from unpaid participants concerning a master thesis project.

The interpretation of primary data has occurred through a reviewing process where each of the researchers has reviewed the data material separately, before meeting up together to discuss the findings and interpretations. In this way, we have been able to establish a framework for how we wanted to structure the empirical findings section and code the quotes into different categories. A weakness of our study is the researcher's limited experience with qualitative studies. Another

weakness is that technology is developing at a fast pace, and it is hard for the decision-makers to keep control of all the things that are happening within the ecosystem. We have not experienced that the informants have provided wrong information, but we are aware that the ecosystem is complex and that aspects can evolve out of the knowledge of the participants.

3.7.2 Transferability

Due to the explorative nature of our study, the aim is not to be completely representative, but rather to "maximize the range of information uncovered" (Guba, 1981, p.81) Since our objective has been to obtain in-depth knowledge on the embryonic stage of a digital ecosystem in the context of the welfare technology industry, we did not aim to have a representative selection that can make our findings to a general rule. On the other hand, our mission has been to provide new insight to the field of ecosystem emergence.

Furthermore, to obtain a strong transferability in qualitative research it is important to provide a good and detailed description of the study (Lincoln & Guba, 1985). Through making sure that our paper has a complete and well-arranged presentation of the research question, -design, context, findings, and interpretation, we make room for other researchers to evaluate whether our research can be generalized to other contexts that are of relevance for them. To facilitate this, we introduce our paper with a complete introduction of the case study as well as we have presented a detailed plan on how we have conducted the research methodology. Additionally, our most important findings have been visualized in a model explaining the main results of our study.

3.7.3 Dependability

To secure dependability in a study one can make use of an external supervisor that is going through the process of the study (Guba, 1981). With help from our supervisors, parts of this study have been carefully evaluated and approved. In addition to evaluating our methodical choices, our supervisors have possessed knowledge around our case study. Since we constitute a part of the DIG project, which both our supervisors are a part of, they were capable of giving us feedback on the methodology and the case study. Another way to establish dependability is by documenting all changes that occur during the study (Lincoln & Guba, 1985). In this chapter, we have presented the methodological choices of our study which involve all the changes we have made. This includes how the research topics and respondents' choices have evolved, and how our findings

have led us to gradually develop the conceptual framework. The changes have had a significant impact on our study, and a good description of this will thus enhance dependability. The elements we have reviewed in credibility, transferability, and reliability will also influence the overall validity of the study and is something that the supervisors have included in the assessment.

Furthermore, researchers must be aware of how to reach the informants, gain their trust, and obtain solid data from them (Saunders et al., 2019). Before meeting our contact person, we were determined on building trust, which is important in qualitative studies. Therefore, we have emphasized a serious conversation where we have tried to be completely open. We wanted to avoid any of the respondents to be insecure about our usage of data and their anonymity. Henceforth, we started every meeting by informing the respondents on this, as well as we had handed out the *Declaration of Consent,* which is enclosed at the end of this paper, some weeks in advance. We have also informed them that they can contact us at any time.

3.7.4 Confirmability

Confirmability and dependability can be assessed at the same time by having a supervisor going through the data, findings, and the methodology of the paper (Lincoln & Guba, 1985). In this study, we have had our supervisors assist in the creation of the interview guide and they also gave feedback multiple times regarding methodological choices, findings, and discussion. Our supervisors have also conducted a thorough review of a final draft, which has supported us with second-hand opinions. The elements we have reviewed regarding the credibility, transferability, and dependability have also influenced the confirmability of the study in total.

3.8 Ethical issues

In the context of research, ethics refers to the standards of behavior that guide your conduct in relation to the rights of those who become the subject of your work, or are affected by it (Saunders et al., 2019, p. 239). There are many ethical issues to consider when conducting semi-structured interviews. For our study, the most important are ensuring confidentiality of data and maintenance of anonymity of the respondents (Johannesen, 2011).

In our study we seek to find answers to the questions from both the actor's point of view, and the respondents' more personal views. However, to obtain this, we need to gain trust from the

participants. To ensure every respondent's interest we anonymized the data when we accessed them. To exemplify we have not explained in detail any of the participants' roles or mentioned their title. This ensures that our respondents cannot be identified. Regarding the mentioning of organizational names these are mostly public organizations in Norway where all the information except the transcribed interviews are available online, and the thesis is written as a collaboration between us, NHH and Telenor. Therefore, we have focused on making the respondents anonymous. The organizational names are relevant for us to include because they are key in understanding the context.

Furthermore, we found it important to secure a safe handling of the data. If the data we collect ends up astray, it might negatively affect the respondent, ourselves as researchers or NHH as a research institution. In order to ensure the anonymity of our interview objects, we established codes to keep the names of the respondents from appearing in the transcribed material. The codes that connected each respondent to the letter were kept in another document. All of the audio recorded was deleted after the transcription process. When saving the data across different files we also made sure to save them locally on our personal computers which need personal passwords to enter. Regarding the recording of the interviews, we used a separate unit which was safely stored in one of the researcher's homes in a locked box. After the completion of our thesis the confidential information and transcribed material will be deleted.

Confidentiality was ensured throughout our project, we followed the guidelines provided by Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS. They also approved our declaration of consent which is attached at the end of our paper. When creating this declaration, we used a template from NSD to ensure that all the guidelines are considered and customized this template to make it relevant for our research. Additionally, we made sure to underline that the study was voluntary and that the participants are free to withdraw the whole interview or parts of it at any time. After the agreement of participation, all data are anonymized.

4. EMPIRICAL FINDINGS

In this chapter we will present the findings based on our analysis. These findings provide the basis for the discussion in chapter 5. First, we present our findings about today's situation and what has led to the establishment of a digital ecosystem. Second, we focus on the problems we have identified and make assumptions about what is expected within the next five years. We found that there is a complex problem which creates a need for companies to move from traditional value chains towards collaborative networks. Second, we found a need for an initiator role which creates a drive towards solving the complex problem and coordinating the efforts of the parties involved. Furthermore, we found two key aspects describing the establishment phase of this ecosystem; technological architecture and governance. Within technological architecture we will present how Telenor has developed from being an initiator to taking an integrator role ensuring that the solutions work together. Looking at how the ecosystem can develop in the future we present the findings as expansion, competitive forces and governance. Alongside the elements we have uncovered a parallel and continuous process of involving internal and external stakeholders. In the end we present how the digital ecosystem is expected to be characterized within the next five years.

4.1 A complex problem

The first key topic identified was the presence of a complex problem. The respondents focused on challenges regarding capacity problems related to demographic issues, the Norwegian municipal structure, and unexploited potential of technological advancement.

First we found that there are societal problems regarding the amount of elderly- and sick citizens and increased life expectancy. Norway fears a growing imbalance between the amount of young and elderly people leading to rising costs and capacity constraints at institutions and hospitals. The amount of elderly- and sick citizens and life expectancy are on the rise at the same time as we know from our respondents that the number of beds and rooms in healthcare institutions will remain the same. When we asked the respondents from Telenor about how they decide which services to develop they focused on societal development and customer demand. The expert also states that every municipality is expected to offer digital welfare technology to the inhabitants. This is illustrated by the first citations below.

Today there are 80,000 Norwegians with dementia. In 20 years, there will be 160,000. In Norway there are 40,000 beds in nursing homes and this amount is expected to be stable. This means that very many people with dementia will have to live at home, therefore the municipalities are very focused on offering great solutions for patients living at home […] (R1)

All the Norwegian municipalities are likely to offer welfare technology to their elderly citizens. (R3)

Furthermore, we found Norway's fragmented organization to be challenging. Nationally there are 11 counties consisting of 356 municipalities. Each of these units have a high degree of autonomy and they have their own administration choosing which systems and actors to involve. Additionally, we found that the demand varies to a large extent across municipalities. Some municipalities have used welfare technology for a long time and others have never used it. Also, the municipalities are cooperating on some areas within healthcare and work independently on other areas. The cooperative initiative in Agder is considered unique.

The health sector is a fragmented sector, we have 11 counties and 356 municipalities where every unit has a high degree of autonomy. And it is not easy to coordinate these solutions. Also, what fits one place is not likely to fit elsewhere. (R3)

Our services match the customer's demand. The customers are very different, some possess a high degree of knowledge, some municipalities have joined forces. (R2)

Agder has been quite unique in that they have a fairly uniform strategy for how to deliver welfare technology to an entire county. At the same time, they facilitate standardization of IT solutions. Other counties, on the other hand, have no cooperation. The Agder municipalities organize in a way where everything is bought as a service, while the neighboring municipalities do everything themselves. (R1)

When questioned about the pressing issues within healthcare, the respondents emphasized a high degree of complexity and inadequate solutions. We found that there have been many attempts to solve these issues, but the success rate has been low. Furthermore, one of the respondents points out that it is the systems and devices that are inadequate, and not the competencies of health

personnel. Due to the fragmented municipal structure and lack of cooperation, healthcare is now characterized by a vast amount of systems and solutions. Architectural characteristics also make it difficult to make the systems work together.

> *[...] healthcare is more complex than other sectors. It treats hundreds of different diseases, there is a specialized workforce, enormous amounts of medicines, and it requires a lot of competence [...] this must be reflected in the digital solutions. Additionally, the health sector is fragmented which makes it challenging to coordinate the solutions, and what will be suitable in one place, may not be suitable at the next location. This has led the efforts throughout the last 30 years to have a low degree of success. (R3)*

> *In general, welfare technology is a complex matter. There are sensors and databases creating and collecting the data, protocols that send stuff through ICT-communication [...] and response centrals that capture the alarms and distribute these. It is a large network of actors. (R3)*

> *[...] there are many different systems and that is what constitutes the biggest challenge when it comes to exploiting new technologies and increasing their range. It is challenging to make all these systems communicate [...] One of the nurses I talked to explained how he had five separate applications he needed to update for just one process. (R5)*

Another challenge is the willingness to share data among the actors. Due to the fragmented systems, it has been challenging for newcomers to enter the market, which has led to a poor environment for dealing with competition. When questioned about this, the expert within healthcare responded.

> *For instance, we have seen in the special healthcare service that companies such as Dips, which is the main supplier of journal systems, not has been particularly positive to let other actors access their data. Similarly, we have seen the same regarding the journal systems in the municipal sector. Eventually this has led to conflicts where the suppliers have felt that they have been kept out from the market. (R3)*

Summarized, all the respondents stated that the sector is in the middle of a digital transformation. In combination with capacity constraints, a fragmented municipal structure, and slow technological advancements, a vast and complex problem is represented. Private and public actors

are developing solutions to solve the problem. The solutions need a high degree of innovation, collaborative efforts through close interaction and many competencies.

4.2 Initiator

So far, we have found an increasing interest surrounding welfare technology and a problem that the government has a high interest in. Further we found that there is a combination of public and private actors causing an ecosystem to emerge. We call this an initiator role where the public initiator constitutes the demand side. This facilitates other actors to provide solutions and we present the ones that are involved today. In the end of this section we present an overview of the Welfare Technology Ecosystem.

4.2.1 The public initiator role

Following the complex structure of the problem, the government established the Directorate of eHealth in 2016. The directorate has an authoritative role which is divided in three parts; 1) a clear voice and professional advisor, 2) setting the terms within healthcare, and 3) creating a common direction.

> *[...] we shall facilitate, create clear guidelines and explain these guidelines. [...] explaining the guidelines for what each actor can do is important for innovation. [...] therefore we have a common strategy for eHealth creating a clear direction. (R4)*

Until 2020 the Directorate of eHealth was responsible for welfare technology platforms such as *Velferdsteknologisk Knutepunkt* which is a national platform connecting welfare technology with electronic patient journals (Norsk Helsenett, 2019). Today, *Norsk Helsenett* owns and operates the platforms and the directorate has an increased focus on the authoritative role. Furthermore, the Directorate of eHealth has a deliberate intent to establish an ecosystem. They believe this will lead to a higher degree of value creation and innovation.

> *The Directorate of eHealth was split in January. Norsk Helsenett now owns and operates the national solutions and the directorate has a clear regulatory and authoritative role. (R4)*

We [the Directorate of eHealth] believe that through an ecosystem, the actors are free to explore new technologies within a set of limits [...] we believe this is important for innovation and the government's institutions role is to create a basis for innovation. (R4)

The Directorate of Health and the Directorate of eHealth annually gives recommendations to the municipalities regarding welfare technology. In 2014 it was recommended to convert from analog to digital safety alarms (The Norwegian Directorate of Health, 2015). Additionally, it was recommended to digitalize alarm receptions and offer mobile safety alarms. The municipalities in Agder followed the recommendation and decided through a regional coordination group, *Regional Koordineringsgruppe* (RKG), to implement safety- and warning technology within 2020 (Regional Koordineringsgruppe 1, 2018). The aim of RKG is to 1) ensure that Agder is the leading Norwegian county in using welfare technology, 2) stimulate research and development in the county and 3) create intermunicipal coordination.

Through the analysis we found that the municipalities have initiated three relevant projects which have created the starting point of the ecosystem; 1) *Felles anskaffelse trygghets- og varslingsteknologi* to ensure a joint procurement of welfare technology, 2) *Kommunal responssentertjenester* to create a functional response center for alarms triggered by welfare technology units, and 3) *Innføring Velferdsteknologi Agder* to manage intermunicipal solutions.

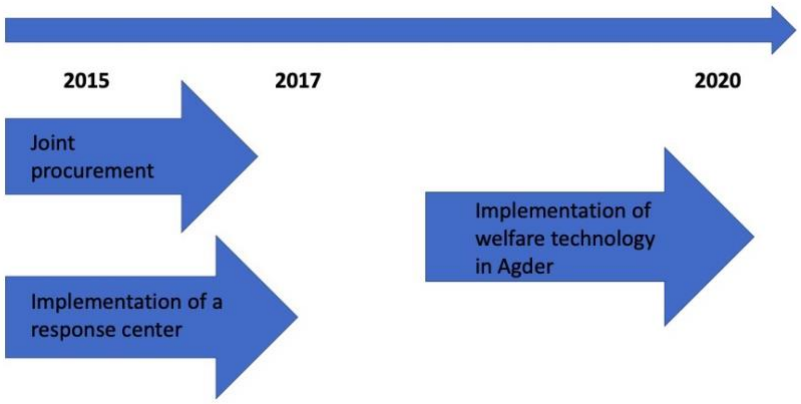

Figure 2: the sequence of projects.

The procurement process started by RKG achieving authorization from 21 municipalities to buy safety- and warning technology. Nine municipalities were included in the initiative by having

options to join at a later stage. As part of these agreements each municipality is committed to use the same gear and technical solutions. The procurement was completed in 2017 and Telenor was chosen as the full-service provider. To handle the alarms from the digital units Agder received a mission from the Directorate of Health in 2015 to establish a national response center (Regional Koordineringsgruppe 1, 2018). Telenor delivered the solutions and the response center has been operational since 2017 (Arendal Kommune, 2017) (see appendix I for more information).

The third project aims to create efficient solutions for welfare technology and intermunicipal cooperation (Regional Koordineringsgruppe 1, 2018). First, the project focused on coordinating the replacement of analog- with digital technology and implementing safety- and warning technology by the year 2020. Second, the aim has been to motivate intermunicipal cooperation, common solutions and innovative thinking. Third, the project was set to achieve a stronger competence regarding welfare technology throughout the municipalities. These three subprojects have worked as a support- and coordination system across the municipalities.

Summarizing these findings, we found that there is a public demand for welfare technology and the establishment of an ecosystem. So far, there have been three projects leading to a public procurement of welfare technology, establishment of a response center and an increased focus on coordinating these efforts. This demand side must be in place for other actors to provide solutions and create new businesses.

4.2.2 The private initiator role

Our findings regarding the project structure mapped an important feature stating that welfare technology mainly is a part of the municipalities' healthcare services offered to end users. Telenor's selling point occurs through public tenders and they are never in direct contact with the user. Public tenders are commonly defined independently by each municipality, but in Agder it is done through RKG. A combined effort has changed the attitudes towards contributing to the sector in the form of welfare technology. Consequently, we found that the municipal demand works as an initiator for other actors.

> *[…] our development is driven by the municipalities' demand. And this demand is often driven by health organizations. The Directorate of Health frequently gives recommendations to the municipalities, which also contain advices on relevant*

technologies. The recommendation constitutes the demand. All innovation we do, we do it together with our customers. And then we turn to the market of suppliers and seek to find someone who can solve the customer's "pains". (R2)

While explaining how the efforts go from national recommendations, to municipalities, to the service provider and the market of suppliers, we found that the initiator role not only consists of the public's efforts. Before finding this market, Telenor developed an integration platform, named Shepherd, exploiting value from IoT (see appendix H for our definition on IoT) technology. Shepherd's first IoT project encountered welfare technology. Following societal development and customer demand they choose to focus on this.

Our role towards the municipalities in Agder, is that we are the full-service supplier of welfare technology, everything the customers buy […] is acquired through us. Meaning that the individual technological solutions are all parts of our product portfolio which we offer to the customers. A great part of what we deliver is that we make these units and services play together, through integration, with the municipalities' systems. (R2)

Following these findings, we found that the initiator role consists of the efforts from both the public recommendations and the founding of the Directorate of eHealth, and Telenor's establishment of their eHealth department and the development of Shepherd. We illustrate this with the citation below.

I would say it is a combination. We experience that we take the initiative and make early phase investments where the customer's demand is quite modest, and then we perform further development and investment based on the customer's developing demand. This way we can offer attractive services. Based on this it is a combination of our early initiatives and the constant evolving customer demand. (R2)

So far we have seen that the Directorate of Health and the Directorate of eHealth gives recommendations for welfare technology. The municipalities in Agder follow these recommendations and coordinate their efforts through RKG. They chose Telenor as the full-service provider. To provide the welfare technological solutions Telenor has involved several other actors. A complete overview of the ecosystem is provided in figure 4 where single arrows illustrate deliveries going one way, and double arrows show mutual dependencies.

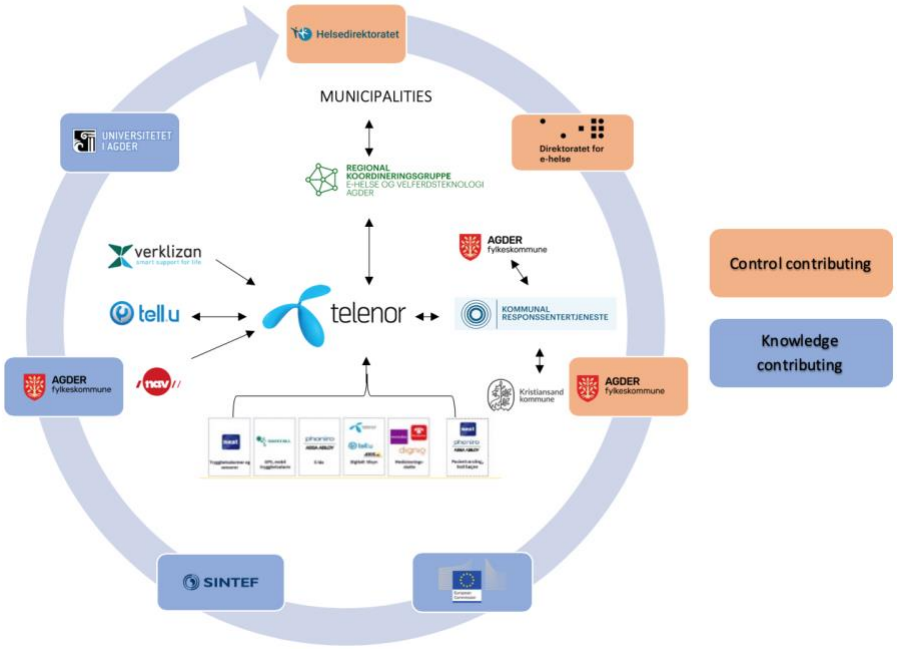

Figure 3: the complete overview of the Welfare Technology Ecosystem.

We found that the public initiator role constitutes a control contributing role that sets the terms for the ecosystem and other actors to grow within. Hence, the Directorate of Health and the Directorate of eHealth create guidelines surrounding who the municipalities should involve. Agder Fylkeskommune has been given an administrative role contributing in the coordination of healthcare efforts. Additionally, we found a knowledge contributing role consisting of the University of Agder, Agder Fylkeskommune, the European Innovation Partnership on Active and Healthy Ageing, and SINTEF. The University of Agder is involved through *Agder Fylkeskommune* and the municipalities. It is a public institution performing research. Additionally, Agder Fylkeskommune has applied to become a reference site and hereby involved the European Commission. Agder achieved the title as a reference site which is given to regions considered to be innovative ecosystems (European Commission, n.d.). Becoming a reference site is expected to work as a catalyst for growth through collaborating with other reference sites to share practices and knowledge. It is also expected to attract stakeholders. Telenor has involved SINTEF as their research partner in R&D projects.

Furthermore, Telenor works as a hub connecting actors through Shepherd. Through the public tender, Telenor involved their portfolio of suppliers as shown in the bottom of the circle in *figure 3*. Additionally, Telenor originally developed Shepherd. Later on, the company transferred the technology to TellU IoT AS (TellU) and involved them as a strategic partner. TellU is Telenor's software partner which offers a cloud-based platform with open APIs to create services with IoT functionality and connectivity (TellU, n.d.). Based on this platform Telenor also created a solution for integrating healthcare devices from other actors than their own suppliers. Hence, they involved the Norwegian Labour and Welfare Administration (NAV). Furthermore, RKG involved Telenor in the establishment of the response center. This is a mutual dependency where Telenor delivered an operational center to the municipality Kristiansand. Today, the center serves Telenor's healthcare customers across the country.

> *[...] the platform was originally developed in Telenor. Then an agreement was formed where TellU was given control and involved as a partner. (R2)*

> *[...] Kristiansand is a subcontractor of a response center solution for Telenor. Users with safety solutions [from Telenor] in their homes are connected to the center. (R2)*

4.2.3 Summary

Summarized, we found that the Directorate of Health and the Directorate of eHealth work as a public initiator. It creates a strategy and facilitates the establishment of an ecosystem. These actors create the terms for the ecosystem and other actors to evolve within. There are also knowledge contributing actors performing academic work and documenting the solutions. Furthermore, we found that Telenor developed Shepherd, an IoT-platform that integrates different technologies and connects actors. Telenor decides who can connect to the platform and constantly seeks to involve the right actors. Together, the public and private actors develop and maintain a drive towards realizing value from welfare technology.

4.3 Establishment

So far, we have presented our findings regarding the demand side as well as how Telenor works as an initiator. These are the drivers behind the emergence of the ecosystem. Now we present our

findings regarding how the situation is today. The findings are divided in the two categories technological architecture and governance.

4.3.1 Technological architecture

Following the complex problem and the initiator roles, Telenor has developed to become something more than an initiator. We found that the company has an integrator role connecting the other actors and enabling actors to complement each other. By being the full-service provider, Telenor has delivered a complete solution. Table 5 provides a short overview of the actors and their contributions to the ecosystem (see appendix I for a more comprehensive explanation of these actors and their contributions). To make these works together Telenor uses Shepherd and has developed several digital interfaces to ensure user friendly solutions for health personnel.

Actor name	Contribution
Neat Electronics	A communication hub integrating devices with Shepherd.
Evondos, Dignio and DoseSystem	Medication support providing an automated schedule for when to take medications.
Safecall	Mobile safety alarms based on GPS to track patients.
Phoniro Assa Abloy	Electronic locks, and a software routing signals from the communication hub to health personnel.
Axis communications and TellU	Digital supervision with cameras from Axis Communications.
Verklizan	A cloud-based and complete solution for response centers within healthcare.

Table 5: an overview of the different suppliers and their contributions.

The integrator role

Shepherd is used to solve integration issues. The platform is developed with TellU, the software partner which offers a cloud platform with open APIs to create services with IoT functionality and connectivity (TellU, n.d.). Shepherd and the integrations are summarized in figure 4.

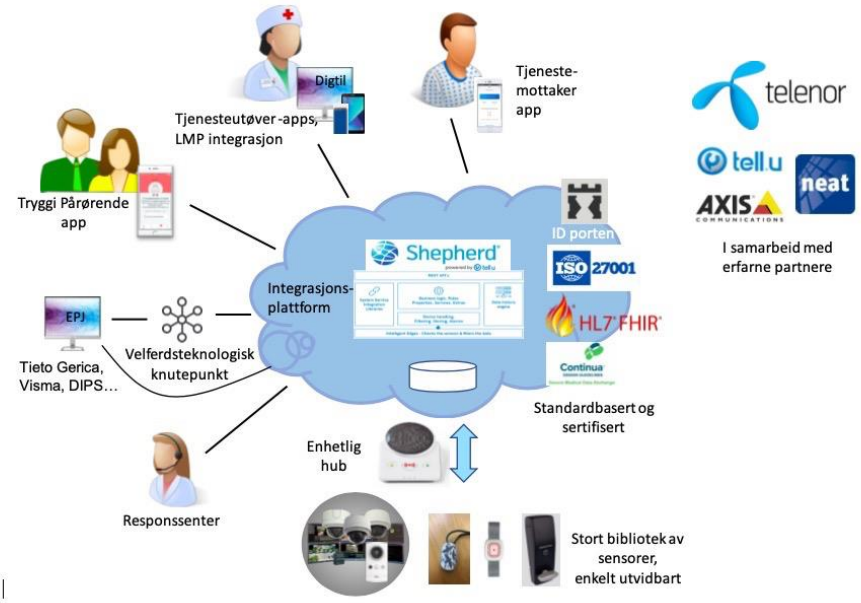

Figure 4: Shepherd and possible integrations (Telenor 1, n.d.).

The figure shows that Shepherd is in the middle and the technological architecture of the platform is built on standards such as ISO27001, HL7 FHIR and ID-porten, and follows the Continua Design Guidelines (see Appendix J for more information). Telenor's portfolio consists of seven digital technologies which are integrated with apps for relatives, interfaces for health personnel, public platforms such as *Velferdsteknologisk Knutepunkt*, and different response center solutions. Telenor facilitates the integration by offering open APIs through a public web address. Combined with the findings from the section about a complex problem we observed that there has been a great need for an integrator. All our respondents stated that Telenor has assumed the main responsibility as an integrator through Shepherd. Telenor has until now been in charge of determining which actors can enter the platform.

> *We choose which players we want to include in our portfolio. This selection process is made on the basis of the demands from the municipalities. Our role is to certify the suppliers and incorporate them into our portfolio which eventually make up the service we deliver to our customers. Therefore, we evaluate our suppliers carefully on the basis of how well prepared they are to integrate into our platform. That is one of our most important criteria. (R2)*

Telenor's role as an integrator is to ensure that the various subcontractors deliver technology that works together and recruit municipalities, which in turn ensures to recruit users of welfare technology. (R3).

The focus on evaluating their subcontractors with emphasis on potential to integrate is presented as a key factor now and in the future. This aspect strengthens Telenor's position as a hub in the ecosystem and towards competition from other ecosystems. With this in mind, Telenor has adopted an "API first approach" as one of their main criteria for who they involve in their portfolio of subcontractors.

With all the innovation we do, we think API first [...] Do the potential suppliers have open APIs that communicate well with our platform and are certified with our response platform. We are also considering whether they have interfaces that allow us to create additional value by integrating the service on the Shepherd platform. We consider ourselves to be strong in terms of supplier evaluations and collaboration. (R1)

Furthermore, Telenor claims a supplier neutral approach. This means that their only intention is to choose the subcontractors on behalf of their services with intentions to make up the best total product. The respondents from Telenor emphasize that even though they have the final word, they choose to be objective when it comes to make the decision of who can join.

We believe it will be important to have a strong integration platform, also we have no interests in relation to suppliers. We are completely supplier dependent. Our mission is to offer the best solutions and the solutions the customers want. And there is really a great deal of openness in it, we have no bindings and preferences, we want to offer the best solutions, and we think it is important to have a strong integration platform and good integration capabilities. (R2)

The integrator role is important with respect to the way the actors are connecting to the platform and the way the relationships between them are formed. Furthermore, the integration of technologies, devices and centrals have to be in place for the ecosystem and Telenor to realize value from welfare technology. According to our respondents this could only happen if the architecture facilitates efficient interaction. Telenor's criteria are formulated through a public web site, allowing actors to develop their systems and enable compatibility with the platform.

The Shepherd platform has open, published APIs [...] and a website where the specifications for the APIs are given. (R2)

From a competitive aspect, Telenor is in possession of key resources. This involves competency about integrative technologies gained from similar work in different industries and supplier relationships with hospitals, connectivity and their IoT platform solution. Open API investments are expensive and time consuming, which makes it crucial for Telenor that suppliers offer this from an early stage. However, Telenor's respondents state that one of the main challenges is that there is a vast variation among their suppliers and their capability to offer open APIs.

Among all the services we provide to our customers, there is a lot of variation in the level of support for, let's call it open APIs. Some players have had an API-first approach and have had it as a strategy over time. Other players have not put it on the agenda until in recent years and are thus not as mature in terms of offering open interfaces. At least it is a challenge that there are varying degrees of open APIs. (R2)

Regarding the market for welfare technology, a conflict of interest appears between the customers' needs and Telenor's willingness to provide integrated solutions. Telenors relationship with Agder as a customer is financially profitable. However, other municipalities do not have the same organizational relationship through a coordination group such as RKG. This means that other municipalities do not have the volume that makes private actors willing to provide the services. Integrated solutions are expensive to develop and operate. Despite the fact that Telenor is making a profit from the Agder project, we found that the suppliers are likely to achieve negative results when they are only based on one customer relationship.

[...] It is also who finances the integration, it is a bit like the chicken or the egg. Customers want integrated services, but they may not have "commitment" on volume for us and our suppliers to finance it. It is also sometimes an issue. That they want integrated services and that customers want it very much, but the question is who is taking the investment costs to get started. (R1)

Furthermore, findings show that an integrator role will be needed in the future as well. Whether it will be Telenor or other players taking care of it is still uncertain. The respondents nevertheless

agree that there is a need for some of the suppliers to work with the customers in order to integrate the technologies.

> *[...] the market is relatively immature with a high degree of fragmentation and individual solutions. To reap the benefits of these services and create a profit, it must be easy for every party to use these technologies alone and in combination. I am convinced that the presence of integrators allowing these interactions is crucial. (R2)*

To summarize, the respondents agree upon that Telenor has captured a role as an integrator. This role consists of facilitating the integration among the members and technologies of the ecosystem, as well as to make sure that it is according to technological, regulatory and social regards. With the API first approach, Telenor makes sure to select their partners with respect to integration capabilities. The control Telenor possesses allows them to both deliver the total value to their customers at the same time as conduct the integration towards the municipalities.

4.3.2 Governance

The next part of our conceptual model is governance. We found that this ecosystem is strongly regulated by contracts and that some important international standards are in focus.

The findings show that the framework contract was signed in 2017 with Telenor as the full-service provider. Each municipality has signed this as an individual contract. It is a contract stating that not everything that is to be delivered is defined beforehand. For the municipalities on the customer side this means that things can change, especially related to innovative solutions Telenor develops. Agder has experienced this as a positive attribute of the contract since welfare technology is quickly evolving. Findings show that most technological solutions from Telenor's suppliers were included in the contract from 2017 but most of the solutions have had software updates. The respondent from Agder also stated that Telenor is the initiator when it comes to further development of their solutions and then present the changes or new solutions to the customer. While finding these positive effects we also found that a challenge within healthcare is asymmetric information. A framework contract in this case is characterized by complexity and the customer is not always aware of every condition. We find that this can lead to one player achieving a relatively high degree of power.

> *The problem is that when dealing with a supplier of complex solutions, it can be very difficult to understand the contracts without the proper knowledge yourselves. And here there is an asymmetric relationship between the technology experts from Telenor, which are familiar with every element in the contract, and the people from the municipality which have limited experience with this kind of contracts. (R3)*

This asymmetric information has not until now been a tough challenge, but we include it as something that might develop in the future. The overall findings show that Telenor has taken responsibility for developing new services and presenting these to the customers for approval. The quote below summarizes the overall perception from the customers' side.

> *There is a lot happening around these services [...] Many of the technologies included in the original agreement from 2017 have been updated and developed […]. In practice a new functionality has been observed and then Telenor is likely to bring this to us [the municipality]. (R5)*

Furthermore, we found that this framework contract has a strict structure. Every municipality in Agder was given the opportunity to sign when the majority signed it. Now three more have signed the contract, leaving six municipalities with the option to sign. This option must be used before 12th of October. Below the strictness of this scheme is exemplified.

> *[...] regarding these other municipalities, they must let Telenor know if they want to activate their option before 12th of October 2020. [...] if not the option is no longer valid. (R5)*

In addition to the framework contract the municipalities signed data management contracts with Telenor. When we asked the project leader from Agder about the data ownership and how these are managed we found that there are strict contracts in addition to national guidelines and legislations. Data management contracts protect the users by giving the data processing actor some rules. Because of confidential matters we were not able to access these contracts and analyze the content.

> *[...] the municipalities who have signed the framework contract also signed data management contracts with Telenor. And for each technology there are own documents for terms of service. Data stored, where they are stored, how long they are stored and who can access this intel is regulated through these contracts. (R5)*

The previously provided overview of suppliers is completely controlled by Telenor. Because of the strong position as an integrator Telenor negotiates and signs commercial contracts with each supplier they want to involve. This is driven by the customer's demand and we found that rather than committing to long term agreements with suppliers, Telenor favors contracts with limited constraints. Such contracts are used because the ecosystem is characterized by constantly evolving technologies and innovation.

> *Everything is negotiated and approved individually, leading to very complex and bureaucratic procedures. (R3)*

> *Contractually, all the actors [...] are based on commercial agreements. [...] We are completely supplier independent. There are no bindings or preferences, we choose solutions available for integrations with everyone. (R2)*

The argument behind the usage of contracts is also linked to the existence of a tradeoff between safety issues related to handling of health data, and the openness of the ecosystem. If there is an issue leading to a choice between safety and openness, safety always wins. This is thought of as a necessity within healthcare.

> *In a functional ecosystem the characteristics of the governance systems must secure a sufficient level of safety for the users. Simultaneously it must be open enough to allow new actors to enter. (R3)*

> *[...] the services are critical for society, meaning that there are particular criteria surrounding both safety, privacy policies and availability. [...] we have to certify the suppliers to make them a part of our portfolio and then make a complete solution which can be offered to the customer. When we evaluate suppliers, an important parameter is how well suited they are for integrations towards our platform. (R2)*

Additionally, there are two mentioned platform suppliers; TellU and Verklizan. TellU is a strategic partner where TellU employees have access to Telenor's offices where they work in multidisciplinary teams. TellU also receives missions from Telenor including more specific services such as digital solutions for patient supervision. These software solutions are developed by TellU, owned by Telenor and licensed to be built on the generic platform. With Verklizan, Telenor has a service-level agreement (SLA). Meaning that his relationship is not a partnership,

but a contract to deliver a service where terms are set in a contract. When Telenor established their relationship with Verklizan it was its own company. From March 2020 Verklizan has become a part of the Enovation Group (Enovation Group 1, 2020). Enovation Group develops and delivers solutions to care organizations. The signed contract will be the same but in the future this service is part of a broader portfolio and network of suppliers and customers through enovation group. Verklizan certifies suppliers and today they have 120 suppliers available which Telenor can choose to use.

> *They have a certification regime for equipment. Today there are 120 suppliers certified on this platform. Meaning that we have a great flora to choose from. (R2)*

Furthermore, we found that there are many standards within the healthcare sector. Here the problem is not a lack of standards, but there is a high number of them. Shepherd is the platform actors must adapt to. The platform is configured by considering the international standards Health level 7 (HL7) and HL7 Fast Healthcare Interoperability Resources, Social care alarm internet protocol (SCAIP) and ISO27001. Respectively, these are standards deciding how to transfer health data between applications health personnel depend on, how to configure- and transfer alarms from digital safety alarms (The Directorate of eHealth, 2018), and how the information security should be (ISO, n.d.). Shepherd is also compatible with ID-Porten, a national solution for login to public services managed by *Digitaliseringsdirektoratet*.

> *Some of the problem is that there is not a lack of standards, but there are many of them. (R3)*

> *There is a standard for [...] social care named SCAIP [...] we have this standard as a criterion for our suppliers. (R1)*

The findings also illustrate that the systems are immature. Today Telenor performs manual and human assessments of who to involve and integrate on the platform. There are two reasons for this. First, the systems are not able to evaluate who can access because the automatic processes are not fully developed and in place yet. Second, the expert and the respondents from Telenor focus on the mentioned tradeoff between openness and safety. There are some standards and interfaces in place, and these are shown on the previously mentioned website, but within healthcare safety matters regarding the user's data will always be number one priority. Meaning that every actor who wishes to join the ecosystem goes through an individual negotiation for approval with

Telenor. Here the data management contracts are of great importance and can not yet be done automatically.

> *Confidentiality, integrity and availability are not parameters that can be adjusted. These are constant and must always be at its best. (R1)*

> *A functioning ecosystem must have a type of governance ensuring safety matters for the user, while at the same time keeping it open enough for new actors to join [...] Within healthcare there are no automatic and mature solutions providing efficient processes for how to join the ecosystem. [...] The actors do not wish to take any chances regarding safety. [...] everything must be individually approved by humans. [...] it makes the bureaucratic procedures much more complicated. (R3)*

The presented findings show that the governance is distributed between Telenor and other regulations such as standardized contracts and open APIs. On the one hand, Telenor possesses the power to decide which actors are entitled to join and which are not. On the other hand, the aspiring members need to satisfy some regulatory and technical criteria which in turn constitute a more natural selection of the members. Together the two aspects constitute the current governance structure in the emerging ecosystem.

4.4 Development

In line with the problem statement, we will try to draw a picture of the emerging ecosystem in the future. Our respondents indicate that several elements are likely to change within a few years, which in turn speaks for a short time horizon. On the other hand, it seems appropriate to choose a horizon distant enough from today, in order to examine some likely changes from the current situation. Hence, a time horizon of five years is considered reasonable and leads us to investigate the situation in 2025. We now present the challenges and expected developments.

4.4.1 Expansion

According to the expert, every municipality is likely to offer welfare technology to the users in a near future. This development has led Telenor to commit a large amount of resources. Telenor wishes to enhance this position as a hub connecting patients and actors within healthcare. Based on the complex problem and the digital technological architecture, we found that Telenor has a

potential for expansion and scaling in Norway. Growth is expected to happen through Telenor achieving customers in public tenders or by establishing direct service relationships with the municipalities. By forming these contracts and relationships Telenor will access more capital.

> *It is clear that Telenor has built up its own unit that they have high expectations for, and financial results are expected because they believe that welfare technology will grow a lot in the years to come. All municipalities are expected to offer welfare technology to their older users. (R3)*

> *[...] our strategy is to invest as we win customers and contracts. (R2)*

> *[Telenor's role] is to be the hub between the patients and the health provider. We wish to enhance and cultivate this role. Our main competence, connectivity, is what the E in eHealth is about. (R1)*

According to the respondents it is challenging to build a business case that sufficient customers demand, and to scale up these services to reach this market. Telenor has managed to create the business case but due to the fragmented organization of municipalities it is difficult to scale the solutions. This is expected to be one of the main challenges for future survival.

> *In reality, our services are very scalable, but there are some municipalities who are only interested in buying the hardware and running the rest themselves, others are looking for a partner and an integrator and one who provides the service from A to Z. The solutions each municipality requests are very different. (R2)*

Telenor expects the Norwegian market to be large enough and that subcontractors want to be a part of this. This is a consequence of Telenor being the full-service provider. Therefore, other actors must go to Telenor to gain access to the ecosystem. Also, Telenor is a pioneer within the field of eHealth.

> *The Agder agreement is huge. In fact, it is a framework agreement involving all municipalities in a whole county. It is considered their way into the Agder municipalities, but it goes via Telenor [...] hence, we have experienced a good interest from suppliers that want to gain access to the market represented by Agder. (R2)*

Telenor also looks at the business case as a future challenge when it comes to the relationships between them and the municipalities. Currently, there are no similar projects as the one in Agder.

The rest of the country is fragmented, and it is expected that it will be difficult to achieve such high volumes within healthcare in the rest of the country. This limits the willingness to invest. Also, the customers are public actors that receive their money from the government and the Directorate of eHealth. The municipalities do not generate revenues, they only offer welfare technology to their users as a part of healthcare. Additionally, there are no subsidies or public funding for private actors such as Telenor. Summarizing this, the customers are expected to demand integrated services at the same time as they are not willing to pay for it or invest in it.

The respondents also stress that many actors talk about all the money within healthcare, but no one seems to have access to this money.

> *Our project receives money from the Directorate of Health […] there are no revenues for det municipalities. It acts as a welfare offer […] Telenor takes the bill. (R5)*

We found that it is currently attractive for suppliers to participate through Telenor. This is because of Telenor's framework agreement giving them control, as well as the expected growth of eHealth. The Directorate of eHealth states that the Norwegian market is not sufficient to attract and make it profitable for the suppliers. Becoming a part of the ecosystem is therefore expected to be a way to access the market and expand to other countries. This shows that at the moment the business model is a challenging issue for the actors in the ecosystem.

> *I think it is important that the ecosystem acts as a steppingstone to international efforts. That we suggest that it is not only Norway, but that when you first do it in Norway there is an opportunity to expand. You can clearly make some money in Norway, but in order for it to make a decent profit, it is not sufficient just to do it in Norway. (R4)*

Following their innovative strategy and developing a strong position is enhanced by a recent development in Telenor's organizational structure. At the end of May, Telenor made a deal with TellU that the department of eHealth will merge with TellU (Telenor 2, 2020). TellU will increase their capital by NOK 40 million and Telenor becomes the largest owner. Operations will continue as normal and the management states that this is a strategic decision which will enhance the company's position in Norway, the Nordics and Europe. TellU already has an office in Sweden and Telenor has operations across Scandinavia and Asia. Also, this is important regarding financial aspects. If the ecosystem is going to expand nationally and internationally sufficient marketing is important to enable acceleration of solutions. This need for investors is partly dealt with by this

new organizational structure. In addition to establishing this new structure, the platform supplier, Verklizan, has over 120 certified suppliers Telenor can involve if necessary. In the future all welfare technology initiatives from Telenor are expected to go through TellU.

> *Every week we are contacted by suppliers of welfare technology who wish to be included. (R2)*

> *It has a little bit to do with pace. The welfare technology is emerging at a fast pace and is therefore dependent on capital investment. If we want to develop our products rapidly, we are dependent on investors' money. (R2)*

Simultaneously, there are some barriers of entry. The healthcare needs in Asia are different than in the Scandinavian countries which can limit the scalability of the solutions. However, Scandinavian countries are similar. Here, the challenge lies within laws and contracts. In Norway, an actor who wishes to participate in a public tender must have similar reference projects in the country. Such terms are expected to be a challenge for expansion to other countries.

> *Telenor is an international company […] but the needs within healthcare are quite different between countries. One main challenge is laws and contracts […] the company who wishes to provide welfare technology must be able to show to other reference projects within the same country.* This creates a barrier of entry. (R1)

Summarized, the findings regarding the expansion of the ecosystem show that the Norwegian market is being developed and there are issues surrounding the fragmentation. Telenor has high expectations for their own work and creates profits. When it comes to other actors the Norwegian market is limited in terms of profits. The ecosystem is therefore expected to expand to other countries. Telenor also creates a drive towards this development by their new organizational structure with TellU, however expansion to other countries is expected to be challenging in terms of new laws and ways of operating.

4.4.2 Competitive forces

Furthermore, as the ecosystem becomes more established, there are some issues regarding Telenor's position and competitive aspects we found are likely to change. We look at the general competitive landscape, changing roles and consolidation.

Competition will still be limited by public tenders where the municipalities are professional actors that always will try to reduce prices. One of the respondents from Telenor compares their welfare technology initiatives to the Norwegian telecommunications market. Telenor is one of the premium brands that differentiate by focusing on quality. Within healthcare Telenor wishes to differentiate by being the best on safety and innovation. When other actors see Telenor's position, the respondent expects the competition to become stronger. Furthermore, we found that the competitive landscape is dynamic with several strong suppliers. Some of them have not been noticed until this year, and some of the larger one's last year are now completely gone. Innovation is key and if an actor does not master this, they will soon be distinct.

> *[The municipalities] shall choose Telenor because of safety, robustness and a stronger agenda for innovation [...] following lower prices will push Telenor further and make us better. (R1)*

> *I am sure Telenor always will strive to meet the municipalities' demand, and that the focus will be on new and innovative services. If Telenor is able to create a service the municipalities do not want today, and make them want it, Telenor will have a competitive advantage. (R1)*

Telenor's role is also expected to experience some changes according to the development of the ecosystem. Today, the company works as an integrator, full-service provider and platform owner. According to the respondents from Telenor their domain is connectivity and they wish to focus on this and build on their platform. Simultaneously, Telenor develops new services that can be integrated with Shepherd, and they wish to continue to do so. Other parts of the value chain, and new ones, are therefore expected to emerge.

> *The domain we want to be and I think is becoming increasingly important for Telenor, is the domain with 5G and prevalence of medical sensors. We are also dedicated to be a provider of welfare technology with remote monitoring and camera-based supervision, so we have great ambitions to continue to strengthen the role we already have taken [...] We have great faith in the role we have with welfare technology at the forefront. (R2)*

By winning the public tender regarding the procurement project, Telenor established a strong position as an innovation partner. Today, this has resulted in a high degree of power with a strong authority related to governance. Related to this the respondents promote a conflict of interest.

Telenor and TellU collaborate on developing Shepherd and govern the relationships with other actors through contracts. Simultaneously, the public has developed and operates other welfare technology platforms. The public's interest is to create equal access to all citizens in a region where welfare technology is offered. When this ecosystem becomes more established and Telenor controls the platform through contracts, it is expected that the integrator's power will increase. This development is not necessarily in the municipalities' interests. Despite this, we found that for innovation to take place, it is important to allow private actors to develop their platforms and solutions, as well as generating a profit. This is closely intertwined with the Directorate of eHealth's wish to be a facilitator and not the innovator.

> *Telenor probably wishes to control the ecosystem through deciding who can be a supplier. This is not necessarily the public's interest. They might want more competition to ensure that the best possible services are available. (R3)*

> *I do not think that private ownership of platforms will become a problem. There will be some platforms that are beneficial for the public to own, that give everyone equal access, and other platforms that the private needs to own. (R4)*

Furthermore, an important issue is whether the ecosystem has enough growth and returns that it is worth competing for, and if the subcontractors wish to have a high commitment to the ecosystem. This is shown by the last sections mentioning low volumes and high investment costs. Building on this analysis an issue related to consolidation is found. We found that the municipalities can work as a driver for consolidation. If they manage to do like Agder through RKG, it is expected that similar projects can be created in other parts of Norway. The respondent from the Directorate of eHealth stated that there is a shift from the municipalities wanting to do things themselves towards knowledge-sharing and more cooperative ways of working. Such a future development can generate higher volumes and thereby revenues, and full-service providers can see a clear commitment from the customers. This can lead to a stronger competition. Here, it is important to mention that the municipalities are likely to use similar procurement processes as the one in Agder through a public tender.

> *[...] previously, the municipalities have wanted to do things themselves and have their own tailored solutions. This is now changing. Knowledge-sharing and open APIs are important. (R4)*

If being a part of the ecosystem does not give a positive result, one will not enter. (R3)

Summarized, we found that as the ecosystem becomes more mature and other municipalities and actors see the success in Agder, it is expected that it can be replicated in other places. Telenor has a unique position and competitive advantages. There are also some roles that are expected to change according to Telenor's competencies and the Directorate of eHealth's wishes for the ecosystem. Third, there is an expected consolidation in the market that can create an even more mature ecosystem and -basis for it to expand to other geographical locations.

4.4.3 Governance

In this part we look at the findings regarding how the governance structure will be in the future. The findings present that mainly the Directorate of eHealth and Telenor will affect the governance structure. We start by looking at the public's expected contributions.

Previous findings show that the Directorate of eHealth has three roles and we found that the directorate wishes to build on this authoritative role. Following a complex sector with several different guidelines, rules and standards, our respondents state that established- and new actors are not aware of what they can- and cannot do. Today there is no public overview of what the actors are allowed to do and the respondents fear that it can limit innovation. Consequently, the directorate wishes to develop the advisory role and have a more efficient system where actors can map their constraints and possibilities. Furthermore, a new legislation within eHealth is being developed. Here the directorate has an important role in developing which terms the sector must align with. Third, the role of creating a common direction within healthcare is set in the directorate's strategy for eHealth.

> *Actors are unaware of what they can or cannot do [...] we [the Directorate of eHealth] believe that when entering an ecosystem, it is important to understand the constraints and possibilities. This is where we wish to help. (R4)*

> *We get many questions regarding what the best way is to do something [...] and we wish to answer these questions [...] If another municipality wants to do something, we can connect them with Agder. (R4)*

It is also important that we do not just tell them what to do. This must be an intermunicipal cooperation with mutual knowledge-sharing. (R4)

By working on these roles, the directorate focuses on different aspects of governance. According to the municipal way of working with projects, the respondents expect that it will be a complex mix of innovative projects and projects where it is more plug and play. The Directorate of eHealth wants to ensure that some parts of the sector is completely open for innovation and new solutions, while others should be systemized in a manner where a municipality easily can copy and implement successful solutions from other municipalities. Successful solutions are expected to be systemized quickly through a recommendation which will be given to the municipalities. An example is shown below by looking at welfare technology for elderly people in Oslo. Expectations are that knowledge-sharing across municipalities will be of great importance. Previously we found that the municipalities usually followed the public recommendations. Hence it is expected that public initiatives will affect the governance structure.

In the start one did not know which solutions to focus on. The municipalities tried several solutions [...] and the best ones were recommended to other municipalities. (R4)

In ecosystems it is important to support different innovation modes. Under high uncertainty it is important to be explorative and innovative, and when promising results appear, one must try to systemize these solutions and steer them in the right direction. (R4)

In Oslo, a welfare initiative for elderly people started at St. Hanshaugen. [...] it then gained some publicity and other districts wanted the same solutions. Afterwards the Directorate of eHealth said that they might develop this into a national platform. (R3)

Summarized, it is expected that some central frames and a context is formed by the Directorate of eHealth. A strategy for eHealth is developed and will be altered in the future, legislations are made, and recommendations will be given based on which solutions are successful. A coordinating role has started to develop. Within this context the public actor wishes that each actor in the ecosystem should be free to develop their own solution and business models. The actors should be able to explore, innovate and use successful solutions in new projects and geographical locations. Here it is important that the public facilitates innovation and the private executes it. This is expected to be possible by the ecosystem's modular architecture.

Following the development surrounding new legislations and standards, the respondent from Agder emphasizes a high degree of change. A need for a standard providing general outlines for actors and their solutions is needed and expected to be developed in a near future. The mentioned legislation on eHealth also has high expectations from the customer's perspective and is likely to be beneficial for the sector through creating a common direction. This is illustrated below.

> *[...] when these things [welfare technology solutions] have been developed there has been a lack of coordination. When a new national standard is in place it will help many actors. Now, there also is a new eHealth legislation which is being developed. (R5)*

Within the context created by the public, we found that Telenor is in control of maintaining the governance structure. Telenor will focus on what the customers want and offer them high quality solutions through integration capabilities. The company already has an API first approach and a public website with different standards and criteria for suppliers to meet if they want to become a part of the ecosystem. Furthermore, subcontractors' configurability regarding APIs are expected to develop. More actors will become certified, either through Telenor's platform, or other welfare technology platforms such as Verklizan's response center platform. This will create a more established sector where suppliers more easily can integrate through Shepherd. We found this focus on open APIs to be one of the main mechanisms within governance.

> *In all innovation we think API first. This is on top of the list in assessing subcontractors. (R2)*

Simultaneously as Telenor controls Shepherd, the municipalities have preferences regarding which subcontractors they wish to use. Additionally, Telenor wishes to maintain an independent relationship with no preferences to which subcontractors to include. Based on these two factors it is expected that the portfolio will have a consistent development towards certifying new actors according to the customer's demand. Hence, increasing the scope of the ecosystem.

> *Our portfolio of subcontractors is a result of our own assessments and the municipalities' preferences. (R2)*

Furthermore, the findings present that the municipalities are expected to have an increased demand for plug and play solutions. Such solutions are characterized by working together with a computer system as soon as they are connected. This development enhances the need for actors to focus on

common standards. Here, we found that Telenor is responsible by integrating the different actors. Hence, they have a high degree of influence regarding which standards the ecosystem should use.

> *[...] Standards occur because more actors digest around them. One example is the Neat Novo creating the communication hub. It follows the SCAIP-protocol which has become a de facto standard. (R1)*

Building on open APIs and creating a basis of standards, the degree of openness is expected to increase. Regarding the previously mentioned tradeoff between openness and safety the expectation is for the involvement of actors to become more open while maintaining strict criteria for what they can and cannot do. A larger part of the evaluation process is expected to be based on standards and open APIs, but the system is expected to never be fully open because of safety issues. This is also focused on who owns the data about the users. According to one of the respondents, different actors must be able to access data through the integration platform. A certification regime is again mentioned as important to establish for further development.

> *[...] there must be a governance structure with a certification regime where actors can be approved for access. (R3)*

We started this section by presenting how a context is made by the public. Within this context we found that it is expected that the governance structure is developed according to an open API approach, standards and certification regimes. This way, the actors' efforts can be coordinated in a common direction while every actor can develop their own solutions, technologies and business models. At the same time as the main focus is on integrations based on customer demand, Telenor and TellU develop new solutions based on their own assumptions and try to develop new business cases. These solutions are not yet integrated with the platform or the subcontractors' solutions. For other actors the mentioned data access is important to ensure that they can improve their own solutions and business models in the future. Further, Telenor's responsibility is to integrate these solutions, whether they have developed the solution themselves or not, and make the actors adapt to a common set of standards and certifications.

> *The silos must be connected [...] every system must interact with each other in a seamless matter [...] here, it is challenging to find a business case that is attractive for every actor involved (R1)*

[...] we also create new solutions, such as digital supervision, that are not yet integrated with other solutions in Agder. (R2)

Summarized, the findings show that both from a customer-, expert and supplier perspective it is expected that standards and certification will be important in combination with the API first approach. Currently, the issues are not reported as great, but this is expected to change in a near future. Telenor's interest is to own their platforms and be in control, while the public's surplus comes from a higher degree of competition that will ensure the best availability of service for the users. The governance structure is expected to be characterized by a higher degree of openness following the development surrounding standards and APIs. This creates a basis for every actor to realize their own business model, while contributing in the ecosystem's common direction.

4.5 Digital ecosystem

Towards the end of the interviews we asked what the respondents think a digital ecosystem within healthcare and our case will look like in five to ten years. The respondents expressed a high degree of uncertainty because of the innovative characteristic of the ecosystem. Nevertheless, the findings show that competition is expected to increase with suppliers taking new roles and other full-service providers entering the market through building their own ecosystems. Customer demand will still be of great importance and Telenor has seen a development towards a more divided demand where the municipalities pick solutions from more than one full-service provider. These solutions must be integrated which enhances the integrator roles importance in the future.

I could imagine there being to or three big suppliers competing and there not being a monopoly. These could each have their own ecosystem where municipalities could join where the best terms are given. And the three ecosystems could compete about the third-party suppliers. (R3)

[...] a few large actors will have many subcontractors. I also believe that the large actors sometimes will have to cooperate to serve the customer. The portfolio [of products and services] the customer wants can be divided between the big actors. And someone has to manage integrations of the solutions. (R1)

We also found out that Telenor does not have a concrete goal to establish a digital ecosystem, but that their focus has been to deliver the best possible services within the welfare technology. Telenor

is aware of this development and familiar with the concept but emphasizes that the customer will be their main priority.

> *Our goal is to be the best full-service provider for the municipalities. We have customer relationships and solutions that can be integrated with the customers' systems. [...]*
>
> *To become the best full-service provider, it is implicitly an ecosystem where we bring partners and subcontractors. Nevertheless, it has not been our strategy to develop an ecosystem and we wish to continue to work on solving the customer's pains. (R2)*

The findings also emphasize the technological aspects related to open APIs. APIs are expected to be the solution Telenor and other actors work towards. Hence, a more open structure with plug and play is expected to develop. Closely related is the trade-off between safety and openness. Safety will always come first within healthcare enhancing the need for an efficient governance structure. As previously mentioned, Telenor's respondents also focus on openness and that actors must have easy access to ensure that the ecosystem serves the customer's demand.

> *it is definitely going to be open APIs [...] and the agreements must be non-discriminating. [...] a key challenge is to ensure that no one will misuse an open platform. (R4)*
>
> *Security, whether you speak about data security for confidentiality, integrity, accessibility or if you speak about security "Safety" in the service regarding what we deliver to the end user / patient, there are no parameters that can be turned up or down, they are constant. So, they have to be on top all the time. (R1)*

Summarized, our analysis shows that the mechanisms of architecture and integrator role, governance, competitive forces and expansion will develop in the near future. Also, there will be a continuous process of involving new stakeholders to satisfy customer demand. The Directorate of eHealth are consciously working to establish a functioning ecosystem while Telenor focuses on the customer demand. The technological aspects of integrations and open APIs will be of great importance and a key challenge is to handle the trade-off that might appear between safety and openness. It is also expected that more than one large full-service provider will exist and this way we can see a landscape of two or three large ecosystems with different focal firms such as Telenor. Issues of monopoly will disappear, and the customers have a broader spectrum of services to choose from.

5. DISCUSSION

In this section, we aim to answer the research question: *What factors need to be in place for the emergence of a digital ecosystem and how can the key mechanisms evolve?* Based on insight from the literature review summarized in section 2.8 and our empirical findings, we have developed a conceptual framework as shown in Figure X. This allows us to make the findings more accessible and systemize the information, as well as structure our findings in a manner that best answers the research question (Saunders et al., 2019). The framework explains the evolutionary stages of a digital ecosystem and looks at how key characteristics are expected to develop. The five elementary phases we have identified are a complex problem, initiator, establishment, development, and digital ecosystem. Additionally, there is a continuous process of involving stakeholders that encompasses more than one phase, as presented in the model below. We discuss this framework against existing research. The discussion is divided into four questions; 1) What needs to be in place for the emergence of a digital ecosystem? 2) How will the roles in the digital ecosystem develop? 3) How will the present architecture and governance change within the digital ecosystem? 4) Will the Welfare Technology Ecosystem ever be a fully digital ecosystem? According to our findings, we do not emphasize expansion, since the findings will be difficult to generalize to other digital ecosystems.

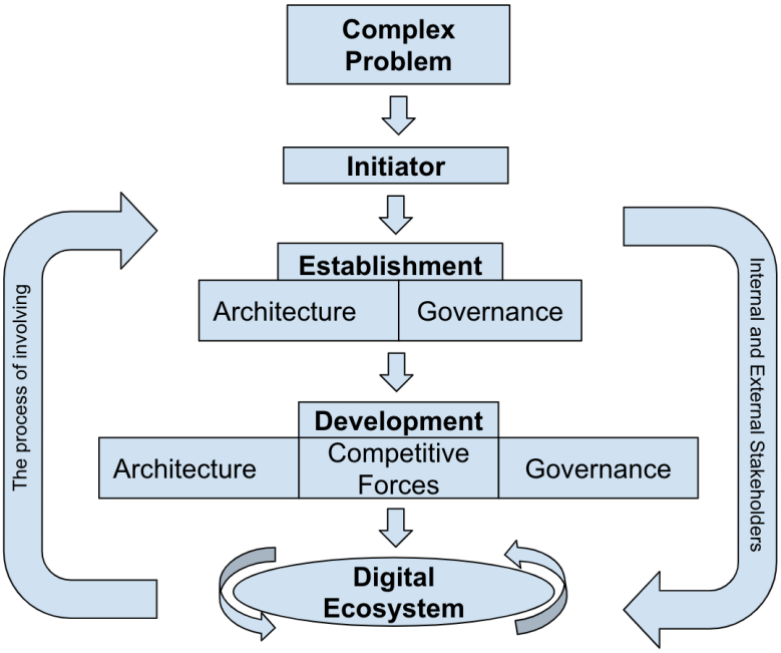

Figure 5: the conceptual model "from an embryonic phase to a complete digital ecosystem".

5.1 What needs to be in place for the emergence of a digital ecosystem?

Ecosystem literature focuses on the value proposition and assumes that every actor works to define the proposition from the start (Adner, 2017; Moore, 1993). Our findings suggest that there is a process before the birth phase. The first phase is that a complex problem appears from the societal capacity problems related to an increasingly elderly population and a fragmented municipal structure. Furthermore, we propose that the solution to these problems demands a high degree of innovation, collaborative efforts through close interaction, and many competencies across geographical areas and systems. Additionally, there are special requirements following the safety of health data.

To solve these complex issues, research focuses on the leader or keystone (Iansiti and Levien, 2004; Cusumano and Gawer, 2002; Jacobides et al., 2018). We believe an initiator role is present before this and that the keystone is not necessarily in place from the beginning. The initiator is someone with a motivation to solve the complex problem. In our case, it is divided in a public- and a private initiator role. The government's response to the problem was to establish the Directorate of eHealth. This department has a deliberate intent to establish an ecosystem. Whether a conscious attitude towards establishing an ecosystem must be in place is unclear (Moore, 1993; Jacobides et al., 2018). We argue that this can occur both ways. Telenor's development of Shepherd randomly became an IoT platform for healthcare integrations. Thus, there is a public initiator role in establishing a strategy and setting terms, as well as a private initiator providing a solution. By generalizing these findings to research on digital ecosystems, we promote the public initiator as the demand side. This is because a public initiator is not always necessary. In cases such as that of Apple, the actors make assumptions about demand and satisfy a latent user need. The demand side will in turn motivate actors to provide solutions. Furthermore, it is not predetermined that the motivated actors are public or private, or whether they develop to become the keystone or not.

Regarding the phases before Moore's mentioned birth phase, it is important to state that this case is different from the emergence of well-known ecosystems such as Apple or Wal-Mart. These ecosystems started in sectors that were less strictly regulated and grew relatively freely (Moore, 1993). Norwegian healthcare is dominated by the municipal structure surrounding public tenders. Thus, it is a distinct case in which competition is organized and an ecosystem can only grow within

a strict context. Other industries in which emergence can start from the public or the authorities that demand a solution can benefit from these discussions. Additionally, we found that the principles for IoT are used in several sectors and the potential is clear. We believe digital ecosystems can imitate other industries and copy the technological solutions with a high degree of success, as well as benefit from already existing competencies.

5.2 How will the roles in the digital ecosystem develop?

We believe the actors' behavior corresponds with what the literature suggests for an early-stage ecosystem. Moore (1993) states that in a birth phase it is important to have a leadership role to ensure that the necessary actors cooperate and to create a basis for complementarity. Other scholars define the leadership role as a keystone or hub (Iansiti and Levien 2004; Jacobides et al. 2018). Telenor has played an initiator role and by controlling Shepherd, it has used their competencies within connectivity and integration from their telecommunications enterprise. This role has developed towards a keystone role which we have called integrator. Hence, Telenor coordinates the efforts of other actors and makes sure the efforts are well suited for the direction of the ecosystem's promise. In this early phase, we see that Telenor manages to attract other actors and draw on these to create the product portfolio. Telenor has managed to create a stable structure with a set of common rules that are governed through contracts. As long as the suppliers and partners follow these rules, they are free to realize their business model. Thus, this is the start of a modular architecture in the digital ecosystem (Jacobides et al. 2018). We also find consensus from Cusumano and Gawer (2002), which states that the platform leader typically is the owner of the platform and main integrator in the ecosystem. By winning the public tender, Telenor's framework agreement enables a high degree of control. Telenor manages to create an attractive system in which they focus on the customer relationship by involving and integrating the right actors. Thus, they enable complementarity between different actors and welfare technological solutions.

Our findings suggest that the keystone role will be of great importance in the next five years and that Telenor will have an integrative role through Shepherd. As we will see under section 5.4, the architecture is not developed enough for the ecosystem to have self-regulating mechanisms. This enhances the role Telenor will have as a keystone and integrator ensuring that all the actors pull in the same direction (Moore, 1993; Boley and Chang, 2007). Despite this, when the Directorate of

eHealth promotes its strategy to build an ecosystem and offers recommendations to municipalities about distributing welfare technology to the citizens, we believe Telenor is forced to have a less formal governing role and more administrative role surrounding connectivity and standards. Our research suggests that Telenor will continue its innovative work as regulations evolve and new recommendations are given. The question of whether Telenor still will operate the welfare technology units in Agder will remain. Municipalities may wish to replace Telenor's solutions with solutions from future competitors. This is a problem Moore (1993) finds to be important to address in a mature phase. Nevertheless, we believe these are challenges that can arise during the whole life cycle and can force roles to change.

According to Dedehayir et al. (2018), we find other direct value creation roles. These are the suppliers of welfare technology and Telenor's partners. Every supplier or partner that wishes to join must attain compatibility with Shepherd's standards and open APIs. This allows Telenor to integrate the technology. Here, Telenor focuses on an innovative strategy of assessing customers' needs in the future, as well as serving existing customer demand. This focus is important in modern business in which many industries experience vast changes and a constantly changing environment. Healthcare can be characterized as fairly underdeveloped with constant developments. Thus, Telenor's portfolio of services is expected to involve several new suppliers through an innovative focus. We believe a digital ecosystem will have constant innovation throughout its life cycle, rather than only at a mature stage (Moore, 1993; Adner, 2017). This is crucial when the environment is dynamic.

Furthermore, the University of Agder, the European Commission, and SINTEF are involved for value creation support (Dedehayir et al. 2018). SINTEF has been included by Telenor and is an active R&D partner. Additionally, the application to become a reference site has made Agder a part of an international arena of knowledge sharing. These actors' contributions are expected to increase knowledge and commercialization. Thus, they provide important insight to enhance the ecosystem's development. We also discovered some entrepreneurial roles. Telenor's focus has been to involve traditional suppliers. Nevertheless, we find that suppliers, Telenor, and municipalities work together innovatively to develop the best solutions. Meaning that even though the efforts do not come from startups, entrepreneurial roles are present. Here, we also see that the regulators are important entrepreneurial roles (Dedehayir et al. 2018). The Directorate of Health

and the Directorate of eHealth provide recommendations and regulations guiding the efforts of the ecosystem. Strategic plans from the Directorate of eHealth are of high importance.

Our findings suggest that the knowledge contributing role will be the same and that more research institutions will gain interest in this ecosystem. Furthermore, the control contributing role will keep developing. The Directorate of eHealth's strategy, advisory role, and term setting role will develop and affect the ecosystem. It is also expected that new regulations, standards, and recommendations will occur. A more openly structured ecosystem is expected to evolve to avoid concentration and to ensure a high degree of innovation. An example can be shown by looking at Telenor's telecommunications business. It has been relatively concentrated leading to poor terms for the users. In 2020, the government regulated telecommunications and demanded Telenor to open for a competitor to establish its network through geographic positions where Telenor has its stations. We believe that to take full advantage of ecosystem thinking, healthcare must have a higher degree of openness. However, if Telenor fails to provide this, the regulator role becomes more active.

5.3 Architecture and governance

In chapter 2 we presented our definition of a digital ecosystem as "loose networks of interacting organizations that are digitally connected and enabled by modularity, where the coordination of actors' efforts happens through standardization of digital interface and that affect and are affected by each other's offerings". Now, we focus on "loose networks", "digitally connected and enabled by modularity" and "standardization of digital interface". We discuss this with emphasis on modularity and governance and compare it to the literature review in chapter 2. Modularity and governance are closely related. Therefore, these two questions can be seen as a coherent part of the discussion.

5.3.1 How will the present architecture develop?

When it comes to the customers' interaction with the ecosystem, our analysis discovered some issues. The municipalities organized through RKG and chose Telenor as the full-service provider. Telenor delivered a seamless and complete solution and enabled a plug and play structure. However, compared to cases such as IoS and Android, we see that the architecture lacks a digital interface where the customers' orders can be automatically given (Jacobides et al., 2018). Apple has created a platform where the user has direct access to applications and other content. In our

case the user is never in direct contact with Telenor or the platform, they depend on the municipality's offering. Because of the public municipal structure with public tenders, it is currently not developed an automated digital interface where a municipality can enter an order of the welfare technology it needs. Additionally, we find a complex backend that needs to coordinate the efforts of several types of loosely coupled actors. This is especially concerned with Telenor, suppliers, partners, and customers. At the moment, Telenor performs strict control and signs contracts with the suppliers to ensure the availability of the complete portfolio. Digital ecosystem theory suggests that the actors are digitally connected, however the solutions for digital interconnected relationships do not yet exist in the Welfare Technology Ecosystem (Nachira et al., 2007; Jacobides, 2019; Valdez-De-Leon, 2019).

Furthermore, we look at the knowledge contributing- and regulator actors (Iansiti and Levien, 2004; Hu et al., 2014; Dedehayir et al., 2016). We expect the knowledge contributors to be included in R&D and innovative projects. Also, the solutions that work well need to be systemized to ensure that the ecosystem can expand. Furthermore, by controlling Shepherd, Telenor manages to adapt the solutions according to regulations, public recommendations, and standards. The content is taken into account through an architecture evolving around the integration platform, Shepherd. It is IoT driven and offers open and publicly accessible APIs that connect the actors to the ecosystem and each other by using digital connections.

The self-interested yet interrelated actors and their technologies also have great potential to complement each other. Thus, enhancing ecosystem thinking where complementarity can arise without being fully hierarchically controlled (Baldwin and Clark, 2000; Jacobides et al., 2018). Telenor has to some extent facilitated complementarity by integrating technologies through Shepherd. Despite this, we believe that the platform is immature, and the potential of complementarity is rising as more technologies become integrated. However, we believe that Telenor does not manage to take full advantage of this. Shepherd consists of manual integrations and is not yet an ideal multi-sided platform ready for plug and play. It lacks automatic interaction. Complementarity is therefore something that tends to evolve throughout the ecosystem's life cycle. We find some support for this in existing literature, but most scholars emphasize how complementarity works within ecosystems and not how it evolves. (Jacobides et al., 2018; Thomas and Autio, 2020).

Even though a modular architecture has started to establish, our findings show that the architecture is currently immature. This is expected from an ecosystem that finds itself in an early phase such as birth or expansion (Moore, 1993). Currently, not all the actors have efficient systems to ensure communication with the platform and the support for open APIs varies. Some are immature, while others have had it on their agenda for years. This variation hinders the self-organizing mechanisms of the ecosystem (Valdez-De-Leon, 2019). We believe the ecosystem is far away from having a standardization of digital interfaces. This is also supported by Moore (1993) stating that a modular architecture will not be the main focus before a later phase. The question is whether Telenor ever will be able to fully reap the benefits of the digital ecosystem's modular architecture. We found that this modular architecture is likely to develop and become more efficient when it comes to connecting suppliers, technologies, and exploiting complementarities. This is motivated by the respondents' emphasis on the integrator role. When the architecture develops, every actor can contribute to the ecosystem as well as independently realizing their business model. This discussion creates a basis for discussing the governance structure of the ecosystem.

5.3.2 How will the present governance structure develop?

We have characterized the ecosystem as being in an early phase with a developing modular architecture controlled by Telenor who won the public tender and owns Shepherd. For further development of the platform, Telenor must consider recommendations from the public actors and evolving legislations. In an early phase of an ecosystem, we believe this controlling role is important. Telenor has developed a strong position that ensures the actors to collaborate in the same direction and not compete with each other (Moore, 1993). In the establishment phase, we argue that the ecosystem benefits from limited competition. If a high degree of competition is present one can expect the suppliers to take over each other's part of the value chain and limit the survival of the ecosystem. By exercising a high degree of control, Telenor removes barriers and enables complementarity (Jacobides et al., 2018).

Furthermore, the analysis shows a tradeoff between the safety of health data and openness to ensure innovation. Data management is regulated through contracts with each customer where the municipality acts in the users' interests. This is important because safety is not something Telenor can compromise and always needs to be guaranteed for the users. The strict safety aspect does in many circumstances constitute an obstacle for Telenor, which in turn makes it hard to create

automatic capabilities that can handle the integration of new actors. This is specific to our case and scholars within ecosystem literature emphasize that hierarchical authority is not present and open source solutions are used in what can be considered as the perfect digital ecosystem (Darking, 2007; Bogers et al., 2019; Jacobides 2019). Despite this, we find support from Bogers et al. (2019), stating that most ecosystems will have a combination of coordinating and informal mechanisms and controlling and formal mechanisms. Telenor emphasizes a high degree of flexibility and does not favor any suppliers. This ensures that the ecosystem is innovative and that they can quickly respond to changing demand. We believe that this is important in a birth phase in combination with a sector that currently experiences rapid development. A combination of formal control and flexible contracts enable Telenor to monitor the market. Thus, these factors enable the survival and growth of the ecosystem.

The absence of favored suppliers also involves the monopolies within the ecosystem. There will not only be one of each type of complementor. When it comes to the ecosystem as a whole, our analysis found that fear of a monopoly against other ecosystems arises. This follows Telenor's strong position as the full-service provider, and this can lead to barriers of entry for other ecosystems. However, we believe that it is necessary with a governing mechanism that sets the terms of participation as well as the degree of exclusivity (Jacobides et al., 2018). Governance in ecosystems where safety is of top priority is therefore expected to never be fully open. Additionally, we believe that there will be regulative changes from the Directorate of eHealth setting the terms, development of standards, and an increasing focus to make a more automated system based on open APIs and a certification regime. As seen within telecommunications, the public has regulated Telenor's business and opened for one of their competitors to enter their base stations (Finstad, 2020). Similar efforts can occur within this sector to prevent high prices and monopoly (Darking, 2007; Dedehayir et al., 2016). The Directorate of eHealth will also set the strategy and terms within healthcare which Telenor must develop their platform accordingly. Additionally, more actors will become certified according to Shepherd's criteria which will broaden the portfolio. This creates a relatively more automatic governance structure where certification according to standards is key, and not Telenor's manual selection of actors. This can alter Telenor's focus from being the actor who governs the contracts to be an actor connecting the municipalities to the supplier they prefer.

Connecting municipalities to suppliers and other relevant actors will only be possible if the modular architecture is further developed. As we argued in the last subsection, no digital interfaces are enabling these digital connections. Such interfaces are crucial if the ecosystem is going to become more mature and efficient. Despite never being fully open the literature never suggests the ecosystem as binary. Our findings suggest that Telenor can benefit from its digital ecosystem, regardless of whether the strict standards are maintained.

5.4 Will the Welfare Technology Ecosystem ever be a full digital ecosystem?

Now, we have discussed the key issues regarding the birth of the ecosystem and how characteristics are expected to develop within the next 5 years. In this subsection, we discuss whether the ecosystem actually can be characterized as a digital ecosystem today and how this matches existing research as reviewed in section 3.1.2, 3.1.3, and 3.2.

In Chapter 2, we defined a digital ecosystem as: "loose networks of interacting organizations that are digitally connected and enabled by modularity, where the coordination of actors' efforts happens through standardization of digital interface and that affect and are affected by each other's offerings". Our analysis and previous discussion show that Telenor's ecosystem is limited and cannot yet fully realize the benefits of a digital ecosystem. First, we believe that the ecosystem is divided regarding scholars' focus on "loose networks of interacting organizations" (Jacobides et al., 2018; Bogers et al., 2019; Valdez-De-Leon, 2019). The knowledge contributing- and regulatory actors are loosely connected, and the relationships are informal. On the other hand, Telenor governs the supplier- and customer relationships through commercial contracts and a framework agreement. This ensures both control and innovation.

Second, we believe that the architecture is immature and currently does not have "digital connections" (Jacobides, 2019; Valdez-De-Leon, 2019). Although Shepherd facilitates a complete customer solution, no mechanisms are facilitating automatic digital connections. Communication between actors is non-digital and ecosystem entrance happens through direct contact with Telenor. Third, healthcare has for the last thirty years been characterized by fragmented efforts and a coordination problem has arisen. The literature states that the digital ecosystem's "coordination of actors' efforts happens through standardization of "digital interface" (Valdez-De-Leon, 2019). We

believe Telenor has managed to start a modular architecture in which every supplier can work on their objectives as long as they adapt to Shepherd's criteria and standards. Also, the suppliers and customers begin to realize the value in becoming a part of the solution. Shepherd and Telenor's innovative approach has removed barriers towards complementarity. Additionally, Telenor works as a keystone and hub in this early phase to ensure that the actors pull in the same direction. According to our definition of digital ecosystems, this factor and the aspect of complementarity show that the actors "affect and are affected by each other's offerings". The motivation to join Telenor's ecosystem is further enhanced by their control of the framework agreement and the offerings available in Agder.

Through this discussion, we see that some elements of the definition of a digital ecosystem are limited. As previously mentioned, a digital ecosystem is not binary, it cannot be divided into the categories "digital ecosystem" and "not a digital ecosystem". Due to the high degree of regulation within the healthcare sector, our findings suggest that the Welfare Technology Ecosystem will most likely never be as open as ecosystems in other sectors. Safety will always be a top priority and will not be compromised. Consequently, we argue that there will be strict rules for participation and exclusivity. Nevertheless, we believe that this trade-off between safety and openness is important within healthcare and we still argue that the welfare technology ecosystem has the potential to one day reap the benefits of a fully digital ecosystem.

When the ecosystem becomes more established and potential profits are clear, we believe competition will be important to consider (Moore, 1993). Our respondents promote that the future healthcare sector is expected to have two or three paramount leaders, and Telenor can be one of them. This will result in increased customer power, as well as the limitations following a monopoly disappearance. Additionally, it will be important for the keystone to ensure that their ecosystem is the standard and best fit, in order to attract both new actors such as suppliers and partners and to attract customers (Moore, 1993). Standardization of digital interfaces will be a key characteristic, which allows actors to have a plug and play approach. If Telenor manages to create this, it will enhance the survival and growth of the ecosystem according to scholars (Nachira et al., 2007; Tiwana, 2013; Valdez-De-leon, 2019).

Furthermore, it will be of vital importance to evolve and ensure that the ecosystem remains relevant. An ecosystem moving from birth to expansion and leadership will be less dependent on

the leader (Moore, 1993). Telenor must be determined to focus on openness and easier entrance. We expect this to be done in a combination of safety and openness, in which openness must be developed and become more equal to safety (Boley and Chang, 2007; Jacobides et al., 2018). This must happen within regulatory terms. The topic of modularity becomes more pressing and we believe that Telenor must focus on developing a more efficient and automatic digital interface in which both suppliers and partners, and customers can interact. A higher degree of attractiveness will take place if the solutions are compatible for other actors and an innovative and digital arena is facilitated. Here, we believe Telenor can establish a strong position as the owner and operator of the digital interface and Shepherd and ensure connectivity between interested actors and the customers (Cusumano and Gawer, 2002; Iansiti and Levien, 2004). These are resources that are hard to replicate and constitute a barrier for other ecosystems to establish (Moore, 1993). Since the issue of safety is of the foremost importance, standards are believed to supersede the importance of informal governance mechanisms, such as trust and self-regulation (Jacobides et al., 2018). Another element we believe is needed to ensure a successful digital ecosystem, is the use of feedback. Digital interfaces allow the actors to contribute value by giving feedback. Telenor can use this feedback to improve their solutions and the overall survival and success of the ecosystem (Weill and Woerner, 2015; Iansiti and Lakhani, 2017).

Regarding survival and success, research by McKinsey estimates that companies with an ecosystem approach and actors that are part of an ecosystem have higher earnings compared to those who are not (Bughin et al., 2019). Telenor has already adopted the “buying” not “making” mentality and outsource production of welfare technology (Valdez-De-Leon, 2019). As the architecture develops it is expected to further lower the transaction costs and by developing this digital ecosystem, Telenor can outcompete traditional value chains. We believe healthcare is dependent on ecosystem thinking and new ways of generating relatively higher value through interacting networks. Complex problems cannot be solved individually.

The key characteristics will develop with an emphasis on openness within the demands of data safety. However, it can never be as open as ecosystems in other sectors and may not be able to reap all of the benefits of being part of a digital ecosystem. Nevertheless, we believe digital ecosystems are not binary and characterize the object of analysis as a digital ecosystem.

6. CONCLUSION

6.1 Conclusion

The purpose of our study has been to answer the following research question: *What factors need to be in place for the emergence of a digital ecosystem and how can the key mechanisms evolve?* In order to address this question, we have performed an exploratory and qualitative single case study of the emergence of a digital ecosystem within healthcare and welfare technology. We reviewed existing literature to create a theoretical background and establish a solid basis to illuminate the research question. Furthermore, we investigated internal documents from Telenor and public information on the ecosystem actors' websites to create an overview of the digital ecosystem. Based on theoretical insight and early empirical insight, we performed the first round of interviews to map the digital ecosystem and its emergence and understand the key mechanisms. After this first interview round and the initial analysis, we directed our focus towards future development of the ecosystem and performed a second round of interviews. All interviews were semi-structured and constituted our main data source.

In Chapter Two, we found that research on ecosystems and digital ecosystems is limited, yet sufficient enough for us to establish a solid theoretical background regarding definitions and what constitutes a key mechanism. However, existing literature is underdeveloped, regarding understanding the emergence of ecosystems and how key mechanisms are expected to develop. To illustrate the purpose of the literature review, we foreshadowed its use in Section 2.8. We critiqued existing life cycle theory and other scholars' assumptions, and highlighted theoretical insight on ecosystem roles, the digital dimension, architecture, governance and coordination.

By using this insight as a theoretical basis and analyzing our data, we constructed a framework assessing the embryonic stage and emergence, as well as how key mechanisms are expected to develop towards becoming a full digital ecosystem. Our key findings are structured as evolutionary stages: *a complex problem*, *initiator*, *establishment*, *development*, and *digital ecosystem*. Additionally, there is a continuous process of involving stakeholders that spans the different phases. These topics highlight interesting issues that we believe are crucial for understanding the emergence and development of a digital ecosystem.

We criticized Moore's life cycle by stating that it lacks a thorough understanding regarding what happens before the actors and technologies are in place. Our findings suggest that a complex problem must exist for a digital ecosystem to emerge. Norway is experiencing an increasingly aging population, leading to capacity constraints surrounding the relationship between elderly and sick people, and the number of beds in hospitals and institutions. Additionally, there is a fragmented municipal structure, which has led to an excess of systems and inadequate solutions. These issues could threaten the functionality of the healthcare system. Our research suggests that a higher degree of innovation, collaborative efforts through close interaction, and many competencies are needed to solve this problem. Such problems are far too intricate for one actor to solve alone, and thus there is a need to include other actors and coordinate several efforts.

For the emergence to begin, we found that there is a need for a demand side intervention which motivates other actors to provide solutions. In this case, demand is difficult to analyze because public organizations have a strong interest and an explicit need for welfare technology and the establishment of an ecosystem. However, the development of the integration platform, Shepherd, randomly entered welfare technology before this explicit need was present. We found that the emergence of a digital ecosystem can happen both consciously and unconsciously. The conclusion is that there must be an initiator role which allows for the start of a digital ecosystem. In the Welfare Technology Ecosystem, the initiators are clear. In other cases, one can look at this as the demand side, explicitly stated or latently present, which must exist if a digital ecosystem is to emerge.

Telenor was originally the private initiator. Now, their role has developed towards a keystone and integrator role as a consequence of owning Shepherd and winning the public tender. Telenor has created an initial modular architecture which they control. Following the control of the structure, it also decides the governance structure. The architecture and governance structure are manually controlled through contracts and standards are of the utmost importance. Suppliers, partners and other stakeholders must be in alignment with the platform's criteria surrounding open APIs, in order to become part of the ecosystem. In this early phase, we found strict control to be of great importance. This serves to enhance the survival and growth of the digital ecosystem. By controlling the actors' efforts, Telenor ensures coordination and the delivery of complementary solutions to the customer. It has been especially important regarding issues related to data safety. Within healthcare, the confidentiality of sensitive data is the number one priority and there are

strict regulations and standards that must be followed. Even though a modular architecture arises, and standards become established, there is a lack of automated and standardized digital interfaces, and digital connections. These are characteristics that are expected to develop to become a full digital ecosystem.

Surrounding the digital ecosystem and creating a context, we have illustrated the findings as a knowledge contributing role and a control contributing role. The knowledge contributing role consists of research institutions that will help systemize the efforts, participate in R&D and create an efficient route towards commercialization. The control contributing role consists of public organizations which create a strategy and outline the terms under which the ecosystem will grow. Recommendations, standards and legislation will affect how the digital ecosystem will evolve. Within these frames, the respondents highlight Telenor's integrator role. This role is important because of an immature modular architecture and the control contributing role is expected to push the integrator towards enabling digital and automated connections through standardization and more openness. Integration will focus on automated processes, rather than manual processes with contracts. This will also increase the expectations towards complementarity. By establishing more automated digital connections, complementarities are realized. The automated structure enabling complementarities will also lead to a more modular structure, in which the digital ecosystem is more accessible. Challenges regarding monopolies within the ecosystem are accounted for.

Summarizing the architecture and governance, we found that a digital ecosystem within a highly regulated sector will have a mix of coordinating— and controlling mechanisms. The integrator is likely to provide rules for participation and a degree of exclusivity. Moreover, the architecture becomes more automated and easier to join. This is of crucial importance, as the findings illustrate a continuous focus on innovation. Telenor has an innovative strategy in which it attempts to predict customers' future needs, as well as serve the present demand. As our framework shows, there will be a continuous process of involving stakeholders and developing cutting edge solutions. This strategy will ensure that the digital ecosystem maintains relevance. As the ecosystem becomes more established, other ecosystems are expected to appear and increase competition. Our findings suggest that this serves the interest of the control contributing role, to ensure that a monopoly within welfare technology does not arise.

The concluding remarks illustrate that a digital ecosystem within healthcare can never be fully open because of issues related to data safety. However, it is expected to become relatively more open. A full digital ecosystem can emerge through standards, digital interfaces and automated digital connections. Such mechanisms can have a joint effect on the actors' efforts and the integrator can provide an efficient system and enable complementarities. As the control contributing role evolves and provides relevant terms and legislations, the ecosystem can become increasingly open and accessible, without compromising data safety. Essentially, the integrator role is likely to loosen control and focus on architecture and connectivity. These efforts are important for the digital ecosystem to maintain relevance, as others are expected to see the value of ecosystem thinking in a more mature phase. We conclude by summarizing that a digital ecosystem is not binary, and our findings show that the mechanisms can develop within the frames of the sector and become a digital ecosystem.

6.2 Implications

This study is a single case study aiming to contribute to existing literature on emergence of digital ecosystems and how key mechanisms can evolve. We criticize existing theory and contribute with novel theoretical insight. Additionally, we provide empirical findings and insight that is insular and cannot be extrapolated to other cases. However, the Welfare Technology Ecosystem has a high degree of public interest, complexity and issues related to data safety. Thus, it is possible to generalize our findings within the sector, to some extent. Furthermore, our findings can enhance the understanding of the emergence of digital ecosystems and how key mechanisms are expected to develop. The main findings can contribute to insight regarding how actors are motivated to start an ecosystem and how the architecture, governance, competitive forces and expansion are likely to evolve. Another limitation of our research is the limited focus on the ecosystem's success and profitability. We note that the integrator achieves a positive profit but does not have an overall assessment of the ecosystem's profitability and potential sustainability. Finally, this is an ongoing project, which constrains us to assess findings based on the respondents' assumptions about the future. To underpin these assumptions, we have looked at other research.

6.3 Future research

Following the focus on a single case surrounding what we have coined, the Welfare Technology Ecosystem, it would be rewarding for future research to look at similar cases. Our study can be used to compare the emergence of a digital ecosystem and how mechanisms are expected to develop. Following our focus on the emergence and development of this ecosystem, it would also be interesting to investigate the same case at a later date. Then, it will be possible to analyze how the mechanisms, roles and the digital ecosystem as a whole have evolved. We have also noted that literature emphasizes that an ecosystem must evolve and innovate to stay relevant. It will be intriguing to discover the extent to which Telenor and Agder evolve and innovate.

The healthcare sector is, as mentioned above, a strict sector with high thresholds for safety and personal data. Our case is highly affected by these public directions and we have only analyzed a small part of the sector. Therefore, it would be constructive for future research to investigate how ecosystems are affected by regulation from public actors. Additionally, since we have limited our case to the projects in Agder and Shepherd, it would be interesting to consider how smaller ecosystems could be components of a larger ecosystem. Finally, we limited our discussion to assume that digital technology has clear scaling potential. It would therefore be valuable to investigate a digital ecosystem's expansion characteristics and whether digital technology actually allows for expansion.

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8. APPENDIX

8.1 Appendix A - Declaration of consent

Vil du delta i forskningsprosjektet

Digitale økosystemer

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å foreta en dyptgående undersøke av fenomenet digitale økosystemer. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Dette er en masterutredning ved Norges Handelshøyskole som skrives som en del av forskningsprosjektet DIG. Formålet er å dekke forskningsgapet som eksisterer mellom digitale økosystemer og andre koordineringsmekanismer. Fokuset for vår studie er norsk helsesektor hvor vi skal prøve å forstå hvordan velferdsteknologi kan skape verdi i dag og i fremtiden. Omfanget begrenses til en studie over ett skolesemester og fokuset ligger på en enkelt bedrift.

Det forventes at utredningen og resultatene vil brukes som en del av DIG-prosjektet, eventuelt våre veilederes (professorer) fremtidige arbeid med digitale økosystemer.

Problemstilling er foreløpig ikke tydelig definert. Men den vil omhandle digitale økosystemer og hvordan disse oppstår. Formålet er ikke å fokusere på en enkelt bedrift, men selve fenomenet.

Hvem er ansvarlig for forskningsprosjektet?

Norges Handelshøyskole er ansvarlig for prosjektet.
Marius Bjorøy Hagen og Herman Melbye i samarbeid med NHH og Telenor.

Hvorfor får du spørsmål om å delta?

Du er blitt spurt om å delta i denne studien grunnet du er en sentral person innenfor velferdsteknologi. Kontaktinformasjonen din er oppgitt av en leder i din bedrift som er en aktiv bidragsyter i DIG-prosjektet.

Hva innebærer det for deg å delta?

Du stiller som intervjuobjekt og vil delta i ett eller flere intervjuer. Vi vil utføre et semi-strukturert intervju som vil ta rundt 1 time å utføre. Spørsmålene vil omhandle velferdsteknologisk plattform

utarbeidet av Telenor, teknologier tilkoblet denne plattformen, samt hvordan aktørene arbeider sammen som en del av et digitalt økosystem. Intervjuet vil bli tatt opp ved hjelp av en lydopptaker.

Vi vil også intervjue en bransjeekspert som har arbeidet mye med helsesektoren og økosystemer. På oppfordring fra dere kan det bli intervjuet andre fagpersoner.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

All informasjon og opplysninger som avgis i denne sammenheng vil kun være tilgjengelig for forskere/veiledere ved NHH. I studien kan du bli sitert i anonymisert form (Eksempelvis person A). Navn og koder lagres separat via en koblingsnøkkel på en ekstern minnebrikke. Denne og lydopptak låses bort separat. Du vil ikke kunne bli gjenkjent i publikasjonen.

Databehandlere:
Marius Bjorøy Hagen og Herman Melbye (forskere/studenter ved NHH)

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 1 juni 2020. Alle opplysninger og materiale slettes permanent sammen med transkribert tekst.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

1. innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
2. å få rettet personopplysninger om deg
3. å få slettet personopplysninger om deg
4. å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NHH har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

Marius Bjorøy Hagen: mariusbh96@gmail.com eller tlf.: 41177970
Herman Melbye: melbye.herman@gmail.com eller tlf.: 41363366
Bram Timmermans: bram.timmermans@nhh.no eller tlf.: 55959534 (veileder)
Lasse B. Lien: lasse.lien@nhh.no eller tlf.: 55959726 (veileder)

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Herman Melbye	Marius Bjorøy Hagen
Forsker	Forsker

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Digitale Økosystemer*, og har fått anledning til å stille spørsmål. Jeg samtykker til:
å delta i *intervju.*

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

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(Signert av prosjektdeltaker, dato)

8.2 Appendix B - Interview guide 1. Telenor.

Praktisk informasjon i innledning

Masterutredningen skrives i samarbeid med DIG: Digital Innovation For Growth. Det er et samarbeid med NTNU sin AI-lab. Målet er å gi støtte til ledere for hvordan de i en digital verden kan skape, levere og kapre verdi.

- Forespørsel om opptak
- Definere begrepet økosystem og forhøre oss hva respondenten legger i det

Et digitalt økosystem skal levere noe komplekst. For at det skal kunne realiseres behøver det heterogene aktører og teknologier som typisk komplementerer hverandre. Teknologiene er eid av forskjellige aktører og trenger ikke være felleseie. Det medfører både konkurranse og samarbeid. Koordineringen i økosystemet foregår via standardiserte digitale løsninger som tillater at hver aktør kan realisere sin egen forretningsmodell.

Introduksjon

1. Kan du fortelle litt om din rolle og bakgrunn?

Økosystemet

2. Kan du kortfattet beskrive nøkkelaktørene og de viktigste bidragsyterne til prosjektet og forklare interaksjonen mellom dem?
3. Hvordan påvirkes prosjektet av andre prosjekter?
4. Finnes det noen konkurrenter og lignende løsninger?

Insentiver

5. Hva er Telenors insentiver?
6. Hva er aktørenes insentiver? (Eventuelt deres mangel på insentiver)

Koordinering

7. Hvordan foregår samarbeidet mellom aktørene?
8. Hva var de mest tydelige utfordringene i utviklingsfasen?
9. Hva var det mest tidkrevende i utviklingsfasen?
10. Hva er de mest fremtredende forbedringspotensialene?

Plattformløsningen Shepherd

11. Hvem eier og drifter Shepherd?
12. Hvordan kan en aktør bli en del av plattformen?
13. Hvilke standarder må den møte?
14. Hva gjør Telenor med dataene?

Teknologi

15. Hvordan velges samarbeidspartnere?

Kommersialisering

16. Hvordan er finansieringen av prosjektet?
17. Hvordan skal Telenor og andre aktører tjene penger?
18. Hva trengs for å gå videre fra utviklingsfasen og kommersialisere prosjektet?
19. Eksisterer all teknologi Telenor ser et behov for i dette prosjektet?
20. Hvilke utfordringer er det i forbindelse med kommersialisering?

Oppsummering

21. Hvilke utfordringer har prosjektets videre gang?

Avslutning

22. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren?
23. Er det noe vi ikke har snakket om som du mener vi bør vite?
24. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.3 Appendix C - Interview guide 2. Agder project leader.

Praktisk informasjon i innledning

Masterutredningen skrives i samarbeid med DIG: Digital Innovation For Growth. Det er et samarbeid med NTNU sin AI-lab. Målet er å gi støtte til ledere for hvordan de i en digital verden kan skape, levere og kapre verdi.

- Forespørsel om opptak
- Definere begrepet økosystem og forhøre oss hva respondenten legger i det

Et digitalt økosystem skal levere noe komplekst. For at det skal kunne realiseres behøver det heterogene aktører og teknologier som typisk komplementerer hverandre. Teknologiene er eid av forskjellige aktører og trenger ikke være felleseie. Det medfører både konkurranse og samarbeid. Koordineringen i økosystemet foregår via standardiserte digitale løsninger som tillater at hver aktør kan realisere sin egen forretningsmodell.

Introduksjon

1. Kan du fortelle litt om din rolle og bakgrunn?
2. Hvordan er organiseringen av velferdsteknologi-prosjekter i Agder?

Økosystemet

3. Kan du kortfattet beskrive nøkkelaktørene og de viktigste bidragsyterne til prosjektet og forklare interaksjonen mellom dem?
4. Hvilke andre institusjoner har vært inkludert?
5. Hvilke andre aktører enn Telenor finnes som leverer lignende løsninger?

Insentiver

6. Hva er de ulike aktørenes insentiver for å være en del av prosjektet?

Koordinering

7. Hvordan foregår samarbeidet mellom aktørene?
8. Hva synes du om kontraktene mellom kommunene og Telenor?
9. Hva var de mest tydelige utfordringene i utviklingsfasen?

Systemer og teknologi

10. Hvilke systemer er koblet opp mot responssenterløsningen og andre leveranser fra Telenor?
11. Hvilke standarder må løsningene følge?
12. Hvordan brukes data om brukerne?
13. Kan du si noe om hva som inngår i databehandlingsavtalene med Telenor?
14. Kan du si noe om forholdet mellom Kristiansand og Telenor når det gjelder responssenteret?

Teknologi

15. Kan du fortelle noe om hvordan kommunene utvikler løsninger eller søker opp leverandører av løsninger?
16. Er det etablert et teknisk senter eller driftssenter for løsningene?

Kommersialisering

17. Hvordan er finansieringen av prosjektet?
18. Hvordan tjener aktørene penger?
19. Eksisterer all teknologi dere trenger for å gi brukerne et tilbud?
20. Hvilke endringer medfører velferdsteknologi for dere?

Oppsummering

21. Kan du si noe om innovasjonssamarbeid Agder har med Telenor?
22. Hvilke utfordringer ser du i forbindelse med prosjektets videre gang?
23. Hva er fremtidsplanene med dette og lignende prosjekter?
24. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren

Avslutning

25. Er det noe vi ikke har snakket om som du mener vi bør vite?
26. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.4 Appendix D - Interview guide 3. Expert interview.

Masterutredningen skrives i samarbeid med DIG: Digital Innovation For Growth. Det er et samarbeid med NTNU sin AI-lab. Målet er å gi støtte til ledere for hvordan de i en digital verden kan skape, levere og kapre verdi.

- Forespørsel om opptak
- Definere begrepet økosystem og forhøre oss hva respondenten legger i det

Et digitalt økosystem skal levere noe komplekst. For at det skal kunne realiseres behøver det heterogene aktører og teknologier som typisk komplementerer hverandre. Teknologiene er eid av forskjellige aktører og trenger ikke være felleseie. Det medfører både konkurranse og samarbeid. Koordineringen i økosystemet foregår via standardiserte digitale løsninger som tillater at hver aktør kan realisere sin egen forretningsmodell.

Introduksjon

1. Kan du fortelle litt om din rolle og bakgrunn?
2. I din forskning på velferdsteknologi mellom Norge og Japan omtaler du "digital infrastructures". Kan du si noe om hva dette er i forhold til digital økosystemer?

Initiativtaker

1. Hvor viktig vil det være med en lederbedrift i oppstarten av et økosystem i helsesektoren?

Kunnskap og kompetanse

2. Hva må kjennetegne denne bedriften, hvilke kompetanser, kunnskaper og ressurser?

Forpliktelse

3. Hvordan kan initiatoren legge til rette for at andre vil være med?
4. Hva må den tilby for at et økosystem skal kunne finne sted i helsesektoren?

Interessenter

5. Hvem er de interne og eksterne interessenter i et økosystem hvor verdiforslaget handler om velferdsteknologi?

Etablering

Struktur

6. Hva må ligge til rette for at et økosystem skal kunne etablere seg?
7. Hvordan kan økosystemet tiltrekke seg aktører?

Komplementaritet

8. Hvorfor er helsesektoren mindre utviklet når det gjelder å tilby integrerte digitale løsninger?
9. Hvordan kan en aktør koble seg på i dag for å tilby noe til helsesektoren?
10. Hvordan kan en aktør som Telenor tilrettelegge for modularitet i helsesektoren slik at et mer åpent system kan skapes?
11. Kan du fortelle litt om standarder i helsesektoren?

Koordinering

12. Hvilken rolle som koordinator vil det være behov for i et slikt økosystem?

Styring

13. Hvordan vil man være nødt til å skille mellom kontroll og styring i en etableringsfase hvor man skal styre hvem som skal få være med, sammenlignet med styringen i et etablert økosystem der det gjerne går mot mer konkurranse?

Utvikling

14. Hva tror du må være tilstede for at et økosystem skal kunne gå fra bare en idé og tidlig fase til et mer etablert system?
15. Hva er utfordringene i denne sammenheng?

Samarbeid

16. Hvordan er holdningene til å jobbe sammen og satse på nye innovasjoner?
17. Hvordan reguleres samarbeidene?

Konkurranse

18. Hvilke gevinster kan økosystem-tenkning bidra til for helsesektoren og velferdsteknologi?
19. Hvordan kan det oppstå et sømløst økosystem med løsninger som ikke krever en streng

autoritet?

Veien videre

20. Ved suksess i en kommune/fylke, hva må ligge til rette for at det skal kunne kopieres til andre kommuner/fylker?
21. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren?

Avslutning

22. Er det noe vi ikke har snakket om som du mener vi bør vite?
23. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.5 Appendix E - Interview guide 4. Telenor.

Masterutredningen skrives i samarbeid med DIG: Digital Innovation For Growth. Det er et samarbeid med NTNU sin AI-lab. Målet er å gi støtte til ledere for hvordan de i en digital verden kan skape, levere og kapre verdi.

- Forespørsel om opptak
- Presentere definisjon av digitale økosystemer og poengtere at vi ikke har gjort noen endringer i definisjoner og hva vi legger i begrepet.

Et digitalt økosystem skal levere noe komplekst. For at det skal kunne realiseres behøver det heterogene aktører og teknologier som typisk komplementerer hverandre. Teknologiene er eid av forskjellige aktører og trenger ikke være felleseie. Det medfører både konkurranse og samarbeid. Koordineringen i økosystemet foregår via standardiserte digitale løsninger som tillater at hver aktør kan realisere sin egen forretningsmodell.

Initiativtaker

1. Hva var de største drivkreftene for å etablere et økosystem i helsesektoren?
2. Hvorfor utviklet dere Shepherd?
3. Hvor viktig vil det være med en initiativtaker?
4. Hvordan kan en initiativtaker legge til rette for at andre vil være med?
5. Hva tenker dere om den offentlige prosjekt- og anbudsstrukturen?
6. Kan dere si noe om rammeavtalene og databehandlingsavtalene?
7. Hvem er det som eier dataene og hvem er det som prosesserer de?

Etablering

Integratorrolle

8. Hvordan er holdningene til å jobbe sammen og satse på nye innovasjoner?
9. Hva tror dere blir Telenor sin rolle i fremtiden?
10. Tror dere en totalleverandør og leder-bedrift i sentrum vil være viktig i helsesektoren?

Styring i systemet

11. Hvordan vil man være nødt til å skille mellom kontroll og styring i en etableringsfase hvor man skal styre hvem som skal få være med, sammenlignet med styringen i et etablert økosystem der det gjerne går mot mer konkurranse og åpenhet?

Utvikling av systemet

12. Er det noen aktører som mangler for at verdi fra velferdsteknologi skal realiseres?
13. Ved suksess i en kommune/fylke, hva må skje/ligge til rette for at det skal kunne kopieres til andre kommuner/fylker?
14. Tror dere vi får mange regionale/små økosystemer, eller få store?

Konkurranselandskapet

15. Dersom vi antar at verden nå er mer utviklet og helsesektoren er blitt et system preget av større grad av innovasjon og åpenhet. Hvilke gevinster og ulemper vil det medføre?
16. Forskning sier at et økosystem kan skape merverdi for flere parter ved at det er karakterisert som åpent og enkelt å slutte seg til. Hva er deres tanker om et system der det ikke er en aktør som kontrollerer hvem som kan tilby tjenester?
17. Kan dere si noe avveiningen mellom trygghet/sikkerhet og åpenhet i helsesektoren?

Styring i fremtiden

18. Hvordan vil Telenor ha kontroll over økosystemet i fremtiden?
19. Hvem vil være eier av velferdsteknologi-plattformer i fremtiden?
20. Hvilken verdi skal dere gi som skal tiltrekke fremtidige aktører?
21. Tror dere at telenor kan måtte ta en annen rolle?

Avslutning

22. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren?
23. Er det noe du føler vi ikke har snakket om som vi bør snakke om?
24. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.6 Appendix F - Interview guide 5. The Directorate of eHealth.

Masterutredningen skrives i samarbeid med DIG: Digital Innovation For Growth. Det er et samarbeid med NTNU sin AI-lab. Målet er å gi støtte til ledere for hvordan de i en digital verden kan skape, levere og kapre verdi.

- Forespørsel om opptak
- Presentere definisjon av digitale økosystemer og poengtere at vi ikke har gjort noen endringer i definisjoner og hva vi legger i begrepet.

Et digitalt økosystem skal levere noe komplekst. For at det skal kunne realiseres behøver det heterogene aktører og teknologier som typisk komplementerer hverandre. Teknologiene er eid av forskjellige aktører og trenger ikke være felleseie. Det medfører både konkurranse og samarbeid. Koordineringen i økosystemet foregår via standardiserte digitale løsninger som tillater at hver aktør kan realisere sin egen forretningsmodell.

Introduksjon

1. Kan du fortelle litt om din rolle og bakgrunn?

Direktoratet for eHelse

2. Kan du kort fortelle hvorfor direktoratet for eHelse ble opprettet?
3. Hvordan vil du oppsummere rollen deres?
4. Vi har blitt fortalt at direktoratet ønsker å utvikle helsesektoren med fokus på velferdsteknologi til et økosystem. Kan du fortelle litt om motivasjonen bak?

Initiativtaker

5. Hvilken rolle ønsker direktoratet å ha?
6. Hvordan tror du utviklingen av økosystemet passer med den offentlige prosjekt- og anbudsstrukturen?

Etablering av økosystemet

Integratorrolle

7. Hva tenker du om Telenor sin rolle som integrator?
8. Hvem bør ha denne rollen?

Styring i økosystemet

9. Hvordan skal økosystemet styres?
10. Hva tenker du om tillit i økosystemet?

Utvikling av økosystemet

11. Hva er hovedutfordringene fremover?
12. Ved suksess i en kommune/fylke, hva må skje/ligge til rette for at det skal kunne kopieres til andre kommuner/fylker?
13. Hvem tror du kommer til å eie de teknologiske plattformløsningene i fremtiden?
14. Hva er ønskelig?

Konkurranselandskapet

15. Dersom vi antar at verden nå er mer utviklet og helsesektoren er blitt et økosystem preget av større grad av innovasjon og åpenhet. Hvilke gevinster og ulemper vil det medføre?
16. Forskning sier at et økosystem kan skape merverdi for flere parter ved at det er karakterisert som åpent og enkelt å slutte seg til. Hva tenker du om et system der det ikke er en aktør som kontrollerer hvem som kan tilby tjenester?
17. Hvordan skal økosystemet legge til rette for å tiltrekke nye aktører?
18. Kan du si noe avveiningen mellom trygghet/sikkerhet og åpenhet i helsesektoren?
19. Hvordan tror du private løsninger kan integreres med offentlige plattformer i fremtiden?

Styring i fremtiden

20. Hva tenker du om at Telenor har kontroll over økosystemet?
21. Samsvarer ønskene til det offentlige med det private?
22. Hvilken verdi skal dere gi som skal tiltrekke fremtidige aktører og eksisterende aktører?

5.0 Avslutning

23. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren?
24. Er det noe du føler vi ikke har snakket om som vi bør snakke om?
25. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.7 Appendix G - Interview guide 6. Telenor.

Utvikling i fremtiden

1. Kan Telenor skalere sine velferdsteknologiske tjenester til utlandet?
2. Hvordan tror du utviklingen av standarder kommer til å være?
3. Hva tror du vil karakterisere Telenors utvikling fremover?
4. Tenker du at konkurransebildet vil endre seg fra i dag?
5. Vil det være et ønske om konsolidering i markedet?
6. Hvordan har dere tenkt til å håndtere konkurranse fra andre aktører som prøver å etablere seg innenfor velferdsteknologi?
7. Hva er planene for markedsføring og distribusjon?

Avslutning

8. Hvordan ser et fullverdig digitalt økosystem ut i helsesektoren?
9. Er det noe du føler vi ikke har snakket om som vi bør snakke om?
10. For å forstå prosjektet bedre, er det noen du mener vi bør snakke med?

8.8 Appendix H - Digitalization and IoT.

Modern literature distinguishes between digitization, digitalization and digital transformation. (Osmundsen, Iden & Bygstad, 2018). Digitization is the conversion of analog to digital information. This is the first step in a digitalization process and is considered the basis for further development. The introduction of a digital medical record is an example of a digitization process. Second, digitalization is the process of utilizing digital technology to change one or more socio-technical structures (Osmundsen, Iden & Bygstad, 2018). Digitalization arises as a result of individuals in the organization embracing digital innovation. Digital innovation is the common term for the introduction of a new product or technology that creates value for adopters and has been developed by combining digital technology in new ways or with physical components (Osmundsen, Iden & Bygstad, 2018). Electronic keys and digital medicine dispensers are examples of services that Telenor has been able to provide as a result of digitalization. The last step is digital transformation. It occurs when a business uses digital innovation over time, allowing for significant changes in the way cooperations work or a significant transformation in the whole industry.

Closely related to digitalization is IoT. It is the process of connecting things and devices to the internet (Haller, Karnouskos and Schroth, 2008). Hence, enabling technological objects to become parts of business processes. For IoT systems to be realized all the components need to have a form of data-sensors which communicate with each other. The aim is for these devices to report in real-time and improve efficiency. Human to human- and human to machine communication are no longer necessary to transfer data. As more and more of our daily used and wearable devices follow the IoT, the need for human presence in certain areas disappear. Telenor's solutions in the healthcare sector are based on principles for IoT and is an example of an industry where IoT-driven systems take over more and more of routine based jobs.

8.9 Appendix I - Technologies constituting the full-service solution

After winning the public tender in Agder, Telenor has had six main deliveries (Telenor 1, n.d.). The findings show that the first four are related to the procurement process and which devices users have in their homes and the larger institutions have installed in their patient rooms. The last two deliveries are related to the response center.

Neat Electronics

The first delivery is the procurement of safety alarms and -sensors which have been installed in homes and institutions. Integration with the response center is included. Telenor offers the digital safety alarm Neat Novo, delivered by Neat Electronics. It is a communication hub connecting up to 48 different types of wireless sensors (Telenor 1, n.d.). It works with 2G, 4G, Wifi and Bluetooth. This creates a digital hub connecting alarms, sensors and cameras for digital supervision and needs to be in place for the signals to be transferred to alarm center or health personnel. Some of the sensors are smoke sensors, door sensors to register patient activity, temperature sensors, voice sensors and incontinence sensors. The communication hub also allows for third party connections. One example is connecting gear from *Hjelpemiddelsentralen.* This is governed by NAV and provides healthcare units.

Evondos, Dignio, DoseSystem, Safecall and Phoniro Assa Abloy

Second, devices for medication support, mobile safety alarms and electronic locks have been delivered. Elderly and sick citizens depend on medications and Telenor offers medication support from Evondos, Dignio and DoseSystem which are connected to Phoniro 6000 and the communication hub. The devices use audio- and light signals to remind the user when to take their medicines (Telenor 1, n.d.). Each unit is configurable to ensure specific user routines based on information about medicines, dosage and time. If the units register deviations, such as when users forget to take their medicines, a message will be sent to their dependents or health personnel. Furthermore, one type of mobile safety alarms is delivered by Safecall. It is a global positioning systems technology (GPS) used to track patients (Telenor 1, n.d.). Each unit is equipped with two-way communication that health personnel can use. Telenor has developed an interface for health personnel which enables tracking through map functions. The electronic locks are developed by Phoniro Assa Abloy which allows health personnel to use digital keys through a mobile unit.

Phoniro Assa Abloy

The third delivery is related to the larger health institutions. Telenor has delivered a technology called patient warning to 22 nursing homes. It aims to connect different units, sensors and alarms through IoT. The system is Phoniro 6000 and receives signals from other units. It is integrated with the communication hub; hence it may process signals from the hub and connect with health personnel. It is a cloud-based service which supports 4G and Wifi.

Axis Communications and TellU

The fourth delivery is digital supervision which has been delivered to both private users in their homes and larger institutions. Telenor and TellU have developed this service. Health personnel can use digital supervision when alarms are triggered, or they can be scheduled at fixed times. Telenor provides cameras from Axis Communications and is responsible for quality, safety and service through a complete solution for equipment, communication and applications (Telenor 1, n.d.). Cameras are installed in the user's home or room at the institution. Health personnel use an app where the roles are controlled by an administrator ensuring the correct access.

To summarize our findings regarding the actors and the technological solutions, the presented product portfolio of safety- and warning technology is installed either in the user's home or room at the institution. The value is created by connecting these devices through a communication hub, digital patient notification system Phoniro 6000 or a combination of these.

Response center solutions and Verklizan

To handle the alarms from the digital units Agder received a mission from the Directorate of Health in 2015 to establish a national response center (Regional Koordineringsgruppe 1, 2018). Norwegian municipalities already have a capacity problem related to the number of elderly citizens and the number of beds in hospitals and institutions. Additionally, home care services had previously handled the alarms from welfare technology units. They have a strict time schedule and if an alarm is triggered, they risk having to leave a patient to respond to a more pressing issue. Since 2017 the response center has been operational (Arendal Kommune, 2017). This is Telenor's fifth delivery. Telenor produced, tested and established this response center. Telenor and *Kommunal Responssentertjeneste* use a platform solution from Verklizan. It is a cloud-based solution provided for more than 300 customers where Telenor is one of them. The platform is customizable and flexible which allows Telenor to build user friendly interfaces and keep the data

security at a high level. The last delivery is the the response center's integration with systems from the health sector. So far, it is integrated with *Velferdsteknologisk Knutepunkt* and systems for electronic patient journals where relevant data are stored (Regjeringen, 2016). Today it processes 1000-15000 alarms daily. To create an understanding of how this works we illustrate one of the response center's services.

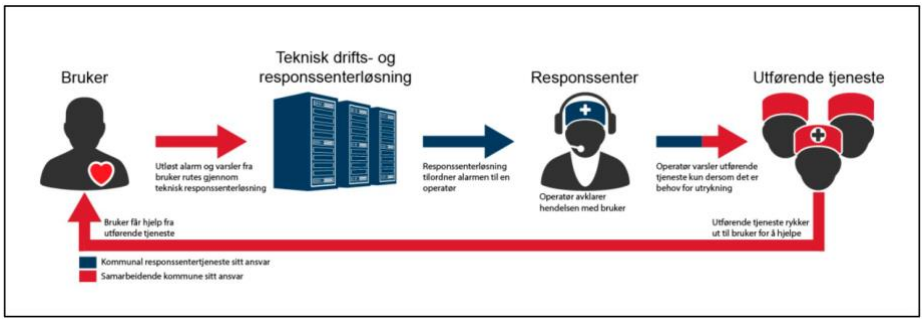

Figure 6: the response center solution in the municipality of Kristiansand.

It starts by a user triggering an alarm which is sent to the response center infrastructure. The system assigns the signal to an operator at the response center. It is then established contact between the operator and the user where the situation is declared. If there is a need for an emergency response the operator notifies relevant personnel. To make this work the responsibility is divided between the response center and the municipality using the response center's services. The response center is responsible for operating the infrastructure and distributing the alarm signals. The municipality using the response center's services is responsible for connecting the user to relevant welfare technology units and integrating this with the infrastructure. Also, the municipality is responsible for having emergency personnel available.

8.10 Appendix J - Key standards constituting Shepherd.

Shepherd is designed by focusing on the standards ISO27001, HL7 FHIR, ID-porten and SCAIP. Additionally, the design follows the Continua Design Guidelines.

ISO27001

ISO27001 or IEC 27001, provides requirements and criteria for information security management systems (ISMS) (ISO, n.d.). The aim is to ensure that an organization can manage the security of their data and critical information through establishing, implementing, maintaining and improving the organization's systems. By following ISO27001, organizations are able to manage the security of financial information, intellectual property, employee details and information entrusted by third parties.

HL7 FHIR

Health level 7 is a standard for how organizations within healthcare can transfer clinical data such as test results from laboratories (HL7, n.d.). It sets the terms for how digital interfaces within healthcare can be designed considering the transfer of data between health personnel. Additionally, it is important for integrated solutions where health data is shared across interfaces and units. Combining efforts from different Health Level standards, HL7 Fast Healthcare Interoperability Resources, aims to create guidelines for more efficient and flexible development of standardized solutions and integrations (The Directorate of eHealth, 2019). Consequently, digital technology can be integrated in healthcare services by following this standard, an organization is able to benefit from open APIs and every actor that is interested can connect to the digital solution.

ID-porten

ID-porten is a national solution for login to public services (Digitaliseringsdirektoratet, n.d.). It is an electronic ID for the citizens of Norway where several login alternatives are given. ID-porten enables health personnel to send electronic information and messages to the user. Creating solutions that are compatible with ID-porten increases the safety of health data and how these are used.

SCAIP

Social care alarm internet protocol is a standard which provides guidelines for how to configure- and transfer alarms from digital safety alarms (The Directorate of eHealth 1, 2018). It specifies

how a protocol should transfer digital messages between the alarm sender and the alarm receiver. This standard is important when it comes to how sensors register data, transfer these to the alarm center, and how the center processes the data.

Continua Design Guidelines

Continua Design Guidelines is an implementation framework that seeks to ensure end-to-end interoperability of personal connected health devices and systems (PCHAlliance, n.d.). The guidelines are based on common standards and focus on four principles. The first principle, unity, emphasizes collaboration between clinical and technical competencies to ensure that the best possible solutions are delivered to the user. Second comes benevolent which sets the focus on doing what the actor following the guidelines thinks is best and doing this in a public and transparent manner. The third principle is inclusive which means that when designing a healthcare solution every contribution must be valued and considered. The last principle, holistic, is to ensure that every involved party works together in the design process.