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Towards Understanding of IoT Ecosystems in the Healthcare Sector

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Master's Thesis
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Laurea University of Applied Sciences **Summary**
Futures Studies and Customer-Oriented Services
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Towards understanding of IoT ecosystems in healthcare sector

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This study aimed to outline an ecosystem to IoT based health/elderly care solutions and to the needs of both single actors and the whole ecosystem. Moreover, the aim was to understand the relations and dynamics between different actors in this ecosystem.

The research questions for this study were: 1. How do industry professionals perceive the current state of health care? 2. How do the digitalization and IoT affect the health sector, and what advancements are needed to speed up the process of digitalization? 3. What kind of potential business models can be seen from a single healthcare actor's point of view? 4. Which kinds of ecosystems may exist in the connected healthcare sector?

Based on previous findings from elderly care, a set of focused interviews were conducted with selected actors in a possible ecosystem. The research section of this project was conducted by open interviews with thirteen selected experts and the objective was to learn about their different perspectives on possible IoT solutions for elderly care in Finland. All the interviews were conducted with a preplanned questionnaire designed and customized specifically to each interview.

Findings from these interviews provided insight to which direction the IoT related healthcare business is moving, as well as present the main barriers and hold ups the industry is currently facing and may still face in the future. Furthermore, this research aimed at providing a perspective to distinct actors within the healthcare industry, such as startups, device manufacturers and the public sector, towards understanding business potential in the emerging digitalization era.

The interviews indicated a clear demand for new intelligent technological solutions in the elderly care services, as well as in the Finnish healthcare and social services sector as a whole. The development of the public health sector is facing challenges caused by outdated systems and rigid organizational structures, as well as legislative difficulties and overall scarce resources.

The research indicated that IoT solutions can help to overcome some of the current challenges in Finnish healthcare, and to innovate new services, provided that also organizational and legislative reforms are done properly. The the social welfare and health care (SOTE) reform is an excellent opportunity, for new and incumbent healthcare business actors alike, to take foothold in the changing business landscape. However, understanding dependencies and roles of all related parties is crucial when designing new types of IoT business solutions.

Further study on this subject could examine a more detailed real life business case study with ecosystemic perspective, or detailed impacts of SOTE reform to the digitalization of care services, or the insurance company perspective - what kind of new business possibilities do insurance companies see with IoT?

Keywords: Big Data, Business Models, Business Models Canvas, Digitalization, Ecosystem, Elderly Care, Focused interview, Healthcare sector, Internet of Things, Piloting, Sensors.

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Laurea-ammattikorkeakoulu **Tiivistelmä**
Tulevaisuuden johtaminen ja asiakaslähtöinen palveluliiketoiminta
Tradenomi (YAMK)

Ari Pesonen & Jussi Sulin

Kohti esineiden internetin ekosysteemien ymmärrystä terveydenhoitosektorilla

Vuosi 2016 Sivumäärä 125

Tämän tutkimuksen tavoitteena on ollut esitellä esineiden internet-perusteista terveyden- ja vanhustenhoito ekosysteemiä, ja tuoda esiin siihen liittyvien toimijoiden sekä yksittäisiä, että koko ekosysteemin tarpeita. Lisäksi tavoitteena on ollut ymmärtää ekosysteemissä toimivien eri aktoreiden välillä esiintyviä suhteita ja dynamiikkoja.

Haluttujen tulosten saavuttamiseksi käytettiin seuraavia tutkimuskysymyksiä: 1. Kuinka alan ammattilaiset kokevat terveydenhoitosektorin nykytilan? 2. Millä tavalla digitalisaatio ja esineiden internet vaikuttavat terveydenhoitosektoriin ja mitä edistysaskeleita on otettava digitalisaation vauhdittamiseksi? 3. Minkälaisia potentiaalisia liiketoimintamalleja voidaan soveltaa yksittäisen terveydenhoitosektorin toimijan näkökulmasta? 4. Minkälaisia ekosysteemejä voi esiintyä tulevaisuudessa terveydenhoitoalalla?

Perustuen aiempiin vanhusten hoivaan liittyviin tutkimustuloksiin, suoritettiin joukko teemahaastatteluja mahdollisesti ekosysteemiin kuuluvien ennalta valikoitujen toimijoiden kanssa. Tutkimusosio suoritettiin teemahaastattelujen avulla haastattelemalla kaikkiaan 13 valikoitua alan ammattilaista, tavoitteena saada tietoa heidän näkemyksistä liittyen terveydenhoitosektorin esineiden internet –ratkaisuihin. Kaikki haastattelut toteutettiin etukäteen suunnitellun kyselylomakkeen avulla, jota muokattiin aina tapauskohtaisesti.

Näiden haastattelujen tavoitteena on ollut tarjota näkemyksiä, mihin suuntaan esineiden internetiin liittyvä terveydenhoito-liiketoiminta on menossa ja lisäksi esitellä tärkeimmät esteet, joita toimiala joko parhaillaan kohtaa tai saattaa kohdata tulevaisuudessa. Lisäksi tämä tutkimus pyrkii tarjoamaan eri aktoreille, kuten start-upeille, laitevalmistajille ja julkisen sektorin toimijoille, digitalisaation aikakaudella realisoituvien liiketoimintamahdollisuuksien ymmärtämiseen liittyviä näkemyksiä terveydenhoitoalalta.

Haastattelujen tulokset osoittavat selvästi uusien teknologisten ratkaisujen tarpeen vanhusten hoivapalveluissa, kuten myös laajemmin sosiaali- ja terveyspalveluissa. Julkisen terveydenhoidon kehitysprosessi kohtaa vanhentuneisiin järjestelmiin ja jäykkiin organisaatiomalleihin liittyviä haasteita. Lisäksi lainsäädännölliset haasteet ja ylipäätään niukat resurssit vaikeuttavat kehitysprosessia.

Uudenlaisten palveluiden menestyksekäs käyttöönotto edellyttää, että henkilöstöhallinnolliset ja lainsäädännölliset uudistukset tehdään kunnolla. SOTE-uudistus tarjoaa erinomaisen mahdollisuuden hyödyntää muuttuvaa liiketoimintaympäristöä, niin vakiintuneille kuin uusillekin toimijoille. Siten toimijoiden keskinäisten riippuvuuksien ja roolien ymmärrys on tärkeää suunniteltaessa uuden teknologian mahdollistamia liiketoimintamahdollisuuksia.

Jatkotutkimukseksi tähän aiheeseen liittyen sopisi tutkia lisää jotain tiettyä yksittäistä esineiden internet -liiketoimintaa nimenomaan ekosysteemin näkökulmasta. Vaihtoehtoisesti voisi selvittää lisää SOTE-uudistuksen vaikutusta hoivapalveluiden digitalisoitumiseen tai esineiden internetin tuomia liiketoimintamahdollisuuksia vakuutusyhtiön näkökulmasta.

Asiasanat: Big data, Business Model Canvas, Digitalisaatio, Ekosysteemit, Esineiden internet, Liiketoimintamallit, Pilotointi, Sensorit, Teemahaastattelu, Terveysala, Vanhustenhuolto.

Ohjaaja: Seppo Leminen, Laurea-ammattikorkeakoulu

Executive summary

Suomi yhteiskuntana kohtaa tällä hetkellä kahdenlaisia terveydenhoidon ja sosiaalipalveluiden haasteita. Ensinnäkin, suomalaiset kansana ikääntyy, kun eläkeläisten määrä kasvaa voimakkaasti suhteessa työikäisiin. Toiseksi, nykyinen taloudellinen taantuma pakottaa julkisen sektorin, muiden toimijoiden tavoin, pärjäämään niukemmilla resursseilla. Nämä haasteet ovat pakottaneet Suomen valtion aloittamaan koko julkisen sektorin ja sosiaalipalveluiden uudelleensuunnittelun, jotta nämä tärkeät valtakunnalliset palvelut saataisiin jatkossakin pidettyä kohtuuhintaisina ja hoitoon pääsyn odotusaika kohtuullisena.

Tämän opinnäytetyön aiheen valinta pohjautui kirjoittajien havaintoihin aiemmasta tutkimuksesta, joka osoitti, että teknologisille ratkaisuille on selkeää kysyntää ja ne voivat auttaa hoitotyöntekijöitä pärjäämään työssään niukoilla resursseilla. Tämä ja muut esineiden internetin (IoT) tarpeet ja edellytykset vaativat lisätutkimusta, jossa terveys- ja vanhustenhoitoalan IoT-pohjaisia ratkaisuja tutkitaan korkean tason liiketoimintaekosysteemien perspektiivistä, tavoitteena saada laajempi kuva tästä toimialasta ja sen markkinoista.

Tässä työssä on pyritty kuvaamaan ekosysteemi IoT-pohjaisille terveysratkaisuille, ja sekä yksittäisen toimijan, että koko ekosysteemin tarpeisiin. Tutkimus tarjoaa tietoa edellämainittuihin aiheisiin sekä pyrkii vastaamaan seuraaviin tutkimuskysymyksiin:

- Kuinka alan ammattilaiset kokevat terveydenhoitosektorin nykytilan?
- Millä tavalla digitalisaatio ja esineiden internet vaikuttavat terveydenhoitosektoriin, ja mitä edistysaskeleita on otettava digitalisaation vauhdittamiseksi?
- Minkälaisia potentiaalisia liiketoimintamalleja voidaan soveltaa yksittäisen terveydenhoitosektorin toimijan näkökulmasta?
- Minkälaisia ekosysteemejä voi esiintyä tulevaisuudessa terveydenhoitoalalla?

Ammattilaisia terveydenhoitosektorin eri alueilta valittiin haastateltaviksi, koska aihekokonaisuus on verrattain uusi ja olemassa olevaa tutkimusmateriaalia siksi niukasti saatavilla. Tässä mielessä tutkimus edustaa tutkimuskehitystä, jossa useita asiantuntijalähteitä tarkastellaan kriittisesti IoT-pohjaisten liiketoimintamallien ja mahdollisten ekosysteemien hahmottelemiseksi. Tavoitteena oli oppia heidän eri perspektiiveistään mahdollisien IoT-pohjaisten ratkaisuiden tarpeista sekä terveydenhoitoalan mahdollisista ekosysteemeistä.

Muutos on vääjäämätön, ja teknologia on auttamassa sitä

Tutkimushaastattelut osoittivat, että Suomessa useimmat menestyksekkään digitalisaatioprosessin edellytyksistä ovat jo kunnossa. Ennen muuta teknologiset valmiudet ovat jo korkealla tasolla, josta kertoo innovatiivisten startup –yritysten määrän kasvu niin teknisten laitteiden kuin ohjelmointisovellusten saralla. Lisäksi nopeat tietoliikenneverkot mahdollistavat ja nopeuttavat digitaalisten ratkaisuiden läpilyöntejä. Edelleen SOTE-uudistus ja muut aloitteet lainsäädännön virtaviivaistamiseksi tarjoavat vielä otollisemman toimintaympäristön terveydenhoitoalan toimijoille.

Kunnollisen käyttöönottokoulutuksen puute voi estää tiettyjen IoT-pohjaisten ratkaisuiden täysimääräisen käyttöönoton yrityksissä ja laitoksissa, ja siksi on ensiarvoisen tärkeää, että perehdyttäjät ja harjoittelijat ovat samalla aaltopituudella. Yritysten voi olla järkevää palkata kouluttajia varsinaisen sovellutuksen kehittäjätiimin ulkopuolelta, koska insinöörit ja hoitajat kokevat usein hyvin eri lähtökohdista tekniset laitteet ja ratkaisut. Työntekijöiden näkökulmasta myös muutosvastarinta saattaa hidastaa terveydenhoidon digitalisaation läpivientiä. Esimerkiksi pelko työpaikan menetyksestä voi aiheuttaa IoT-ratkaisuiden käyttöönottoa vaikeuttavaa muutosvastarintaa työntekijöiden keskuudessa.

Yhteistyö ja yhteiskehittäminen menestyksen avaimina

Tutkimushaastattelut antoivat viitteitä siitä, että ennen kuin IoT-liiketoiminta-aloitteet voivat levitä laajalti terveydenhoitoalalle Suomessa, on entistä tärkeämpää kehittää nykyisiä prosesseja vastaamaan uusia disruptiivisia ratkaisuja. Prosessien lisäksi uusien teknisten ratkaisuiden tulisi mahdollistaa niche-toimijoille kivuton markkinoille pääsy tiettyyn ekosysteemiin. Käytännössä tämä tarkoittaa sitä, että avoimen arkkitehtuurin sovellusratkaisut mahdollistavat pienempien yritysten sovellustarjoaman avointen ohjelmontirajapintojen avulla isompiin ekosysteemeihin. Tällainen hedelmällinen yhteistyö voi hyödyttää kaikkia toimijoita terveydenhuoltoalalla.

Lainsäädännölliset jäykkyydet ja lakien tiukka tulkinta voivat hidastaa IoT-pohjaisten ratkaisuiden yleistymistä. Myöskään liiallinen ja epäreilu kaupallinen kilpailu toimijoiden välillä ei auta uusien liikteoimintamallien joutuisaa käyttöönottoa. SOTE-uudistuksen tuoma paine terveysalan toimijoita kohtaan ja yhä lisääntyvät yhteiskehittämisen hankkeet antavat onneksi tarvittavaa sysäystä IoT-pohjaisten sovellusten käyttöönotolle. Tosiasia on kuitenkin, ettei Suomen talous kestä kovalla vauhdilla ikääntyvän kansan tuomaa rasitetta terveydenhuollon kuluihin, ja se tuo vääjäämättömän tarpeen uudistaa vanhoja prosesseja, sekä kehittää kokonaan uusia.

Ratkaisuntarjoaja korostettuna liiketoimintamallina

Sopivan liiketoimintamallin löytäminen terveydenhuoltoalalle voi tuntua haastavalta, kun toimivia vaihtoehtoja on niin monia. Kuitenkin yksi toimivimmista on ratkaisuntarjoajan malli, jota tässä työssä tarkastellaan tarkemmin. Tämä malli tarkoittaa kokonaisvaltaisen ja räätälöidyn palvelupaketin tarjoamista asiakkaalle. Käytännössä tämä voi olla esimerkiksi räätälöity palvelupaketti sisältäen fyysiset tuotteet, ohjelmiston ja konsultoinnin, sekä ylläpidon palveluna.

Tämä työ sisältää korkean tason Business Model Canvasin, joka on luonnosteltu ratkaisuntarjoajan, ja tarkemmin kulunseurannan IoT-pohjaista palvelua tarjoavan yrityksen näkökulmasta. Tämä canvas esittelee oleellisimmat toimintavaiheet liiketoiminnan käynnistämiseen, sekä yleisimmät pullonkaulat ja sudenkuopat matkalla menestykseen.

Tarkasteltaessa terveydenhuoltoalan liiketoimintamahdollisuuksia canvasin avulla tietyt aihekokonaisuudet nostivat merkitystään. Oikeanlaisten kumppaneiden löytäminen on ensiarvoisen tärkeää, samoin kuin toimivien asiakassuhteiden kehittäminen, jotta tätä ratkaisuntarjoajan mallia voidaan soveltaa tuottavasti. Näin siksi, että tämä liiketoimintamalli nojaa usein hyvien kumppaneiden löytämiseen. On myös hyödyllistä yhteiskehittää ja iteroida valittua mallia yhdessä kumppaneiden ja muiden sidosryhmien kanssa.

Myös tulovirtojen ja kulurakenteen suunnittelu täytyy tehdä huolella. Ansaintalogiikka on yleisesti kehittymässä kohti erilaisia toistuvaperusteisia malleja jättäen taka-alalle perinteiset kertaperusteiset ansaintalogiikat isoine etupainotteisuuksineen. Toistuvaperusteiset mallit voivat jopa sisältää ansaintalogiikoita, joissa maksun suuruus perustuu tiettyyn suoritustasoon tai kynnysarvoon. Kulurakenne on tärkeä, koska teknologian hinta koetaan usein edelleen liian suureksi. Kuitenkin teknologian kehittyessä ja halventuessa jatkuvasti mahdollisuus säätää hinta paremmin vastaamaan asiakkaan hankintabudjettia paranee jatkuvasti.

Kehittyvät ekosysteemit terveydenhoitoalalla

Esineiden internet voi muokata terveydenhoitoalaa monella tapaa. Ennen kaikkea se mahdollistaa uudenlaisten aktoreiden ja yli toimialarajojen muodostuvien ekosysteemien tehokkaamman pääsyn markkinoille. Alustatoimittajan rooli voi vahvistua, koska kaikki IoT perusteiset terveydenhoitoratkaisut tarvitsevat tietyn alustan, jolle ne tullaan toteuttamaan. Lisäksi kaikki big data pitää säilöä jossain, mikä tarjoaa erilaisille pilvipalveluratkaisujen tarjoajille mahdollisuuden kasvattaa liiketoimintaansa. Edellämainittujen lisäksi telealan

toimijat, operaattorit ja analytiikkatoimittajat ovat todennäköisesti niche-toimijoita tulevissa terveystoimialan ekosysteemeissä, joskin niistä voi myöskin muodostua avainpelaajia joissakin skenaarioissa. Nämä ekosysteemit hyödyttävät todennäköisemmin kaikkia sen osapuolia, mikäli ne ovat avoimia. Avoin ekosysteemi tarjoaa parempia mahdollisuuksia startup –yrityksille, koska se mahdollistaa uudenlaiset liiketoimintamallit kuten yhteiskehittämisen.

Tässä työssä on korostettu kahta teoreettista viitekehystä, IoT Business Model Frameworkia (Fugl 2015) ja Value Design – business model design toolia (Westerlund et al. 2014), ja niitä on käytetty apuna luotaessa laajempi kokonaiskäsitys IoT-perusteisesta terveydenhoitotoimialan ekosysteemistä. Tämä laajempi ekosysteeminäkymä yhdistää Westerlundin ja kumppanien arvonmuodostustekijät sekä Fuglin kolmen pääkerroksen organisaation, toimialan ja ekosysteemin. Lopputuotoksena tämä teoreettinen ekosysteemimalli visualisoi tärkeimmät havainnot yhden sivun laajuiseksi ja helposti ymmärrettäväksi kokonaisuudeksi. Lisäksi tutkimuksessa kuvatut liiketoimintamalli- ja ekosysteemityökalut muodostavat selkeän näkemyksen terveydenhoitosektorista ja sen ominaispiirteistä. Niinikään ne esittelevät tarpeellisia toimenpiteitä liittyen hyvin toimivaan liiketoimintamalliin, joka pystyy operoimaan yli toimialarajojen muodostuvassa ekosysteemissä.

Sote-uudistus avaa uusia mahdollisuuksia

Tämän tutkimuksen johtopäätös on, että teknologia, ja tarkemmin IoT, voi auttaa ylitsepääsemään osasta Suomen terveydenhoitosektorin tämänhetkisistä haasteista ja innoivamaan uusia palveluita, olettaen että organisatooriset ja lainsäädännölliset uudistukset toteutetaan kunnolla seuraavien 5-10 vuoden aikana. Sote-uudistus on loistava mahdollisuus, sekä uusille että vakiintuneille toimijoille, saada jalansijaa haastavassa liiketoimintaympäristössä. Eri toimijoiden välinen yhteistyö muodostaa vahvan perustan uusien ratkaisujen ja palveluiden toteuttamiselle. Ilman toimialan aktoreiden asianmukaista panostusta kansalliset sosiaali- ja terveyspalvelut eivät voi jatkossa tarjota samaa korkealaatuista palvelua, johon Suomen kansalaiset ovat tottuneet.

Teknologinen osaaminen on jo korkealla tasolla monessa Suomen kaupungissa, mikä mahdollistaa ketterän käyttöönoton uusien terveydenhoitosektorin ratkaisujen osalta, mikäli tarjooma on käytännöllinen ja osoittautuu kustannustehokkaaksi. Lisäksi tutkimuksemme ehdottaa, että markkinat voivat olla kannattavat sekä isommille toimijoille ja konsortioille, että pienemmille startupeille ja niiden yhteenliittymille. Paikallinen tietotaito voi myös auttaa pienempiä toimijoita löytämään toisensa ja perustamaan dynaamisia terveydenhoito-ekosysteemejä, jotka tarjoavat räätälöityjä ratkaisuja.

Executive summary

The Finnish society is currently facing two-fold challenges regarding healthcare and social services. First, Finland as a nation is aging as the number of pensioners grows considerably in proportion to the working aged people. Second, the ongoing economic recession forces the public health sector, among other operators, to cope with scarcer resources. These challenges have forced the Finnish government to start redesigning the entire public health and social services sector in order to maintain these important nationwide services with reasonable costs and waiting times for treatment.

The subject of this study was selected based on findings from an earlier study by the writers, which indicated that there is a clear demand for new technological solutions to help the employees of elderly care centers to cope with scarce resources. This and other IoT related needs called for further research, in which IoT based solutions for health and elderly care are studied from a high-level business ecosystem perspective in order to get a bigger picture of the industry and its markets.

This study aimed to outline an ecosystem to IoT based health solutions and to the needs of both single actors and the whole ecosystem. The research provides information on the aforementioned topics and aims to answer the following research questions:

- How do industry professionals perceive the current state of health care?
- How do the digitalization and IoT affect the health sector, and what advancements are needed to speed up the process of digitalization?
- What kind of potential business models can be seen from a single healthcare actor's point of view?
- Which kinds of ecosystems may exist in the connected healthcare sector?

Professional people from across the health sector were selected to be interviewed, as the subject matter of this study is relatively new and research material thus limited. In this respect, this research represents a form of development by research, in which multiple sources of information and professional views are critically examined and used to outline possible IoT based business models and an example of a conceivable ecosystem. The objective was to learn about their different perspectives on possible IoT solutions and an ecosystem for elderly care in Finland.

A change is imminent and technology is there to help

The findings from the interviews indicated that most of the capabilities needed to achieve the success of digitalized services in health sectors are in good shape in Finland. Above all,

technological capabilities are at a high level, which is indicated by a growth of new innovative startups related to both technological devices and services. Furthermore, a high-speed communication network enables and eases new breakthroughs with digitized solutions. In addition, the social welfare and health care (SOTE) reform and other initiatives, which aim to streamline the legislation, will provide an even more opportune operational environment for health sector actors.

As the lack of proper education may prevent the full implementation of certain IoT solutions, it is essential that educators and trainees speak the same language. It might be worthwhile to recruit educators from outside the actual core development team as engineers and nurses quite often do not share the same mindset towards technological solutions. Another aspect from the employees' point of view, which may slow down the digitalization in healthcare, is the resistance to change. In other words, if employees fear losing their position, the common resistance may preclude IoT solutions in the health sector.

Co-operation and co-creation keys to success

The research interviews suggested that before IoT business initiatives can widely spread across the healthcare sector in Finland, the need to adjust current processes to match the demands of new disruptive solutions is increasingly important. In addition to processes, new technical solutions should enable smaller niche players to easily implement their offerings to a certain ecosystem. In practice this means that open Application Programming Interfaces (API) enable easier access for smaller actors to provide their software applications or code to a larger ecosystem. These kinds of fruitful cooperations benefit all the actors within the healthcare sector.

Legislation issues and, in more detail, distinct interpretation of laws may slow down the implementation rate of these new IoT based solutions. Furthermore, excessive commercial competition and whitewash between distinct actors is not helping the rapid deployment of new business models. However, the pressure towards healthcare actors caused by SOTE-reform and ever-increasing co-creation initiatives may brighten otherwise sluggish development of new IoT based solutions in the healthcare industry. The fact that Finland as a nation cannot cope with a rapidly aging society is another factor that creates pressure to modify the existing and create totally new processes.

Solution provider model highlighted

Finding a potential business model for new healthcare related business initiatives may feel challenging as there are many suitable business models which can be utilized. However, one

of the most potential is a solution provider model, which is highlighted in this study. The solution provider model means offering an encompassing package of distinct products and/or services to the customer. In practice it would mean customized service packages, including consulting services and product elements and their maintenance.

This study included a high-level Business Model Canvas (BMC) drafted from a solution provider, and in particular IoT solution provider's point of view. In addition to the main bottlenecks and pitfalls, this canvas demonstrates some of the most significant action steps that need to be performed.

With the help of this health sector BMC, some of the subject matters increased their significance. Finding suitable partners is crucial, as well as having well-functioning customer relationships in order to deploy the business model profitably, as the solution provider model rarely can function without partners. Besides the aforementioned, the possibility to co-create, co-plan or iterate a business model with other stakeholders may be beneficial to all the related parties.

What is more, revenue streams and cost structure must be carefully planned. Revenue logic is commonly transforming towards distinct recurring revenue models in the near future, whereas traditional transactional fees with large upfront payment are part of the history. Recurring fees may even include some sort of a fee structure, in which the payment amount is based on performance and thresholds. Cost structure is important in the sense that presently the price of new technology is often too high. However, as technology evolves and becomes cheaper, the chance to adjust the price to better match the customer's budget increases.

Emerging ecosystems in the connected healthcare sector

Internet of Things can reshape the health sector in many ways. First and foremost, it will enable new types of actors and cross-industry ecosystems to gain market position more effectively. The platform provider's role may strengthen, as all the IoT based healthcare solutions need a certain platform to which they will be deployed. Furthermore, all the big data needs to be stored somewhere, which in turn offers distinct types of cloud storage providers a possibility to expand their businesses. In addition, telecom vendors, operators and analytics providers are likely niche players in the healthcare ecosystem, but they may also be keystone or dominant players in some scenarios. The ecosystem is likely more beneficial to all the stakeholders when it is open. An open ecosystem comprises better opportunities for startups and it enables new types of businesses, such as co-creation.

Two theoretical ecosystem frameworks, IoT Business Model Framework (Fugl 2015) and Value Design – business model design tool (Westerlund et al. 2014) are highlighted in this study and they have been utilized to construct a more expanded view of IoT related health sector ecosystem. This expanded ecosystem view combines the value drivers, nodes, exchanges and extracts together with the three main layers of organization, industry and ecosystem. This theoretical ecosystem model visualizes the main results of this study to a single page, easily readable figure. The business model tools and ecosystem models described in this study form a clear picture of the healthcare sector in its entirety and give information about its characteristics, as well as the action steps needed in order to achieve a well-functioning business model operating in a horizontal cross-industry ecosystem.

The SOTE reform opening possibilities

With this study we believe to have established that technology, and more precisely IoT, can help to overcome some of the current challenges in Finnish healthcare, and to innovate new services, provided that also organizational and legislative reforms are done properly within the next five to ten years. The SOTE reform is an excellent opportunity, for new and incumbent healthcare business actors alike, to take foothold in the changing business landscape. Collaboration between distinct actors forms a strong foundation for implementing new solutions and services. Without proper input from industry actors, the nationwide social and healthcare services cannot function with same high quality service level that the citizens of Finland have been used to.

Technological know-how is already high in many Finnish cities, which should be nimble enough to implement new healthcare solutions if the offering is sensible and proves cost-effective Moreover, our study suggests that there can be viable markets for both bigger players and consortiums, as well as for smaller startups and collaborations. The interviews also suggested that regional know-how will help smaller actors to find each other to form dynamic regional healthcare ecosystems with customized offerings.

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1 Introduction and background

This study aims to understand Internet-of-Things (IoT) ecosystems in the healthcare sector. This introduction chapter depicts the current situation and the rising challenges of the Finnish healthcare and elderly care sectors. In addition, recent studies on the subject matter are introduced, as well as an introduction to the upcoming SOTE reform in Finland, which will have a profound effect on how healthcare is organized in Finland. Pertaining to these changes, this chapter also describes digitalization in healthcare. Furthermore, the objective of the study and its research questions, the limitations of the study, and the structure of the study are presented at the end of this chapter.

1.1 The need for healthcare reform in Finland

The Finnish society is currently facing two-fold challenges regarding healthcare and social services. Finland as a nation is aging as the number of pensioners grows considerably in proportion to the working aged people. The ongoing economic recession, in turn, forces the public health sector, among other operators, to make do with scarcer resources. These difficult challenges have prompted the Finnish government to redesign the entire public health and social services sector in order to maintain these important nationwide services with reasonable costs and waiting times for treatment. Elderly care, in particular, seems to be suffering from scarce resources, and the media currently reports about elderly people in institutions as having insufficient care time and exercising possibilities due to the shortage of nursing staff. Politicians currently debate about what is a sufficient minimal requirement for nursing staff per patient, and examples from different municipalities show worrying shortcomings in daily care of the elderly.

The answers to these challenges have to be based on reorganizing outdated structures, processes and legislation to streamline the Finnish healthcare sector. Technology, on the other hand, offers exciting and unseen possibilities to help transform the whole healthcare and social services sector to properly serve today's demands. The emergence of such concepts as Internet of Things and digitalization pave the way for a comprehensive shift of paradigm for every conceivable branch of society or industry. There is a huge need to transform the current reactive healthcare, in which diseases are being treated, towards proactive and predictive healthcare, in which the aim is to keep people healthy in such a way that the amount of diseases within the whole population decreases.

In an IoT themed project study, Pesonen & Sulin (2015) case studied the challenges of a municipal elderly care center tending to the needs of customers' everyday living. Moreover, the object of the study was to outline the kind of business pains that could be accommodated

with the help of IoT based technological solutions. Findings from those research interviews indicated that there indeed is a clear demand for new technological solutions to help the employees of elderly care centers to cope with scarce resources. The most recognized need during that particular project turned out to be safe area movement around the elderly care center premises. This and other IoT related needs called for further research, in which IoT based solutions for health and elderly care are studied from a high-level business ecosystem perspective in order to get a bigger picture of the industry and its markets.

1.2 The current state of elderly care in Finland

In a broader perspective Finland is struggling with a sustainability gap between resources and the cost of maintaining a welfare state that secures adequate pensions and healthcare for every elderly citizen. There has been talk in Finnish media about the weakened quality of elderly care in Finland due to shortage of staff in many care units. If only the most crucial everyday care needs are tended to, many elderly people are in danger of weakened mental health and can suffer from isolation, loneliness, memory disorders and depression. Furthermore, if these physical conditions are not monitored often enough, there is a possibility of undetected serious illnesses and severe consequences as a result. The following sections introduce the KÄKÄTE project and the Arjen katsaus study, which reinforce the notion that both employees and end-customers experience technology in a positive manner.

Elderly care professionals experience technology in a positive manner

Professionals working in the elderly care industry feel that technology is needed in their daily routines. A study related to this subject matter was conducted back in 2014 by TNS Gallup Oy which interviewed 320 elderly care professionals from both the public and private sector. The study was part of the KÄKÄTE project and the respondents were divided to managers (44 %) and employees who conduct normal care work (56 %).

Three out of four respondents experience the use of technology as very useful in elderly care business. Devices, such as falling prevention detection sensors, memory aids, location tracking security solutions and free time related technology, were seen as important even though the respondents did not necessarily have those aids in their own workplace. Major shortcomings are related to education matters. Only 22 % of respondents feel that they got adequate enough technology related education while studying to be a nurse.

Although the respondents work in distinct elderly care units like in domiciliary care and in elderly care centers, the spectrum of technology was still quite narrow. Besides the typical

digital solutions like CRM and security phone systems, a minority of respondents have falling prevention solutions (4 %) and location tracking solutions (11 %) in their premises.

This project study reaffirms the notion that technological innovations can help to improve the quality and efficiency of health/elderly care, albeit the biggest challenges come from reorganizing organizations and tasks. Furthermore, proper education of nursing staff plays a vital role in the successful implementation of new technological aides.

Citizens react positively towards personal monitoring

One of the aspects of implementing new, sensor based health technology, is the citizens' reaction to them. People have to embrace the benefits and importance of using them more in the future. Almost two thirds (61 %) of Finnish citizens want their movement and condition to be monitored with intelligent technology when they reach senior age and live home alone. 37 % of the respondents think that primarily the data related to an exceptional condition should be delivered to healthcare professionals. The second most desired option was the respondent's own adult children. These kinds of results were acquired by the Finnish insurance company LähiTapiola with their Arjen Katsaus study, which was conducted by the research company YouGov Finland in March 2016 on behalf of LähiTapiola. (LähiTapiola 2016)

Based on these findings, it seems that the majority of people are willing to be tracked and just a small minority totally declines these types of services. Another notable point is that privacy seems to be an important factor as the data related to an individual's condition is allowed to be retained solely by healthcare professionals or close relatives. Men and younger respondents react a little more pessimistically towards intelligent technology and remote monitoring. (LähiTapiola 2016)

LähiTapiola states that the research was aimed at citizens who, based on their age, would likely be monitored in the near future. The results from the research strengthen their insights that new types of intelligent digital solutions are needed in order to be able to prolong the capability for elderly people to live home longer without risking the quality of life excessively. (LähiTapiola 2016)

1.3 The reform of the Finnish Social and Healthcare system (SOTE)

The reform of the Finnish Social and Healthcare system (SOTE) is one of the biggest governmental and operational method transformations to have been executed in Finland. The transition applies to hundreds of thousands of public sector employees, as well as services for

all citizens. The primary target is to reorganize providing of social and healthcare services from municipalities to 18 provinces by the end of 2018. (Alueuudistus 2016)

Provinces share the responsibility to organize publicly funded services but they need to assign their service delivery to a separate legal entity, which then competes on an equal footing with private actors, like companies, organizations and communities. The end-customer may choose between private, public and 3rd party sector services at least in basic level services such as health centers. In addition to this, some of the specialist level services will be under competition but details related to the freedom of choice will be published later. (Savolainen 2016)

The provinces will not have the right to collect taxes from citizens. Instead they will receive a certain amount of money from the state, which the provinces can then use to the best of their ability. Consequently, the provinces deliver the services by themselves or together with other provinces. All the services under the end-customer's freedom of choice will be incorporated. Only specialized care services and some public authority tasks will stay under a public monopoly. (Savolainen 2016)

According to the new alignment, each province must organize some of its services, for example primary care, together with a larger collaboration area. There will be five collaboration areas in Finland and each of them has their own University hospital. Those collaboration areas shall be based on common agreements and no governmental structures will be established. (Savolainen 2016)

The state will guide the most expensive functions, such as emergency duties. In case a certain province spends more money than budgeted, it may be forcibly joined to another province. Furthermore, the genuine competition between distinct service delivery actors is expected to streamline the performance. (Savolainen 2016)

1.4 Digitalization in healthcare

Future connected healthcare solutions need to maintain an appropriate level of reliability and security. In general, the level of coverage needs to be seamless. Bandwidth demands are higher when the data transfer flow includes images, video and/or sound. High cost of components may be approvable to healthcare actors if the benefits from the services exceed these preliminary costs. This applies more likely to monitoring solutions regarding prevention, diagnostics or treatment services. (Mazhelis et al. 2013, 24-25).

The Ministry of Social Affairs and Health in Finland has contributed a publication that concentrates on how citizens' social and health information could be utilized. The main idea is to activate the control of life and self-care of a citizen by producing reliable wellness information and services, which could ease the introduction of information. The efficiency and effectiveness of such new service system will be increased with the help of electronical information management solutions. Thus the historical patient-doctor roles shift gradually. (The Ministry of Social Affairs and Health 2015.)

The reform of Finnish Social and Healthcare system (SOTE) will have a huge impact to customer field and information and communication technology (ICT). There will likely be integrations of IT-systems, which in turn provides better breeding ground for new digitalized business models as the amount of open application programming interfaces (API) is increasing. Additionally, different types of quantified self-activities, in which consumer is trying to improve his/her own health instead of relying on healthcare professionals, could have more significance in the future. (Sitra 2015.)

Hay et al. (2012) note that financing trends such as pay-for-performance and accountable care organizations are likely to incite health service providers to seek more efficient and effective means of caring for their costliest patients. Moreover, the health industry needs to commit to interoperability in order for the connected health to become fully integrated into health self-management and healthcare delivery. In addition, standards and guidelines for interoperability of personal connected health devices are necessary in order to fulfill the potential for a technology-enhanced system for healthcare.

1.5 The objective of the study and its research questions

This study aims to outline an ecosystem to IoT based health solutions and to the needs of both single actors and the whole ecosystem. The research provides information for aforementioned topics and aims to answers following research questions:

- How do industry professionals perceive the current state of health care?
- How do the digitalization and IoT affect the health sector, and what advancements are needed to speed up the process of digitalization?
- What kind of potential business models can be seen from a single healthcare actor point of view?
- Which kinds of ecosystems may exist in the connected healthcare sector?

1.6 Limitations

This study primarily focuses on the IoT based solutions for elderly care. Many of those solutions are very useful and potential also in numerous other fields of businesses, but those are intentionally excluded from this study in order to keep the focus on elderly care. Healthcare industry as a whole has been included in this study from an ecosystem point of view as elderly care and healthcare share many attributes.

Other limitations are related to the type of customers and solutions. The main focus is in Business-to-Business (B-to-B) services, in which customer is either a public or a private sector entity within elderly care. The Business-to-Consumer (B-to-C) sector may be mentioned in some parts of this study, but it is intentionally left to the background. This study introduces some examples of both current ecosystems and business models in the market. However, the emphasis is on the possible future business models and ecosystems within the field of IoT. Other types of technological solutions related to digitalization or eHealth apart from IoT, have not been included in this study.

The figure 1 below aims to clarify the limitations in a visual form. The yellow box in the center of the figure highlights the selected topics, such as business models, business ecosystems, elderly care, IoT solution for healthcare, and the B-to-B sector. The area outside the yellow center illustrates those excluded subjects, like e-health, IoT solutions for other industries and the B-to-C sector.

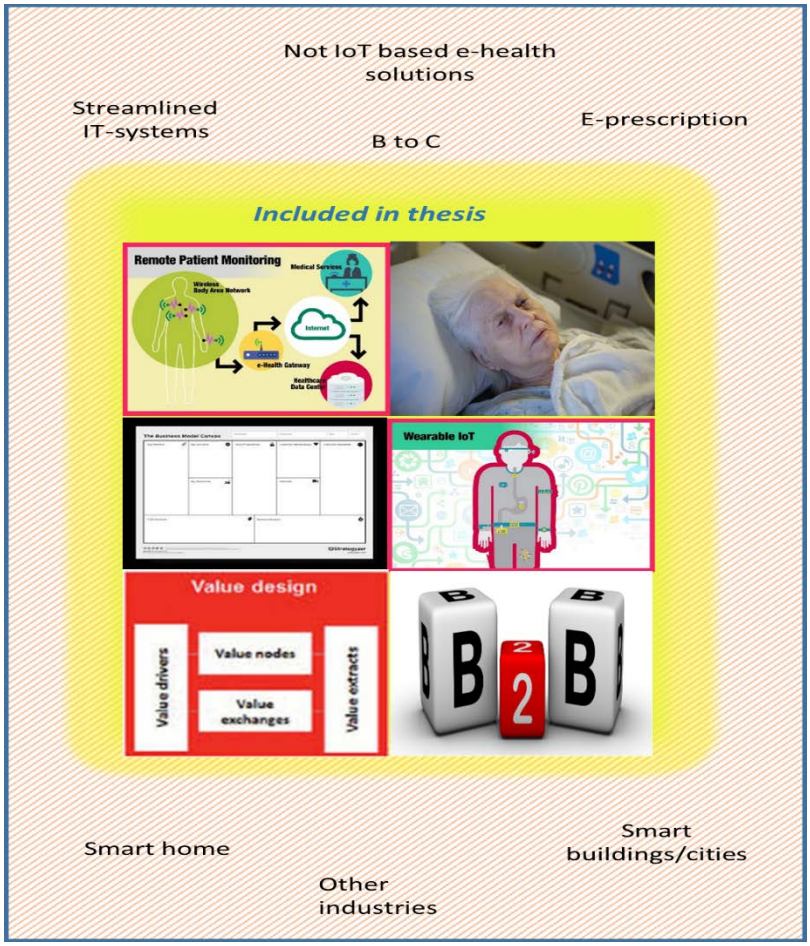

Figure 1. Limitations of the study

1.7 The structure of the study

The structure of this study is presented in figure 2. Besides the introduction part, chapter 1 presents the current state of elderly care in Finland, as well as the objectives of this study. Two previously conducted researches regarding the viewpoints from both citizens and elderly care professionals towards technology, have been included with the purpose of clarifying the current state of elderly care. Chapter 2 concentrates on giving a clear picture about IoT: what it means, which type of terminology exists in the markets and how it may help to streamline the processes in the healthcare sector?

Chapter 3 instead presents the whole theoretical framework mainly concentrating on selected business models and ecosystems. This study pinpoints four carefully selected business models: Business Model Canvas (Osterwalder 2010), Magic triangle (Gassmann 2014), IoT business model framework (Fugl 2015) and Value Design Business Model design tool (Westerlund et al. 2014).

The design of this research is introduced in chapter 4, including a reasoning for the selection of research interview method and data analyzing methods. In addition timeline of the research, research form and interviewed persons are described briefly. Therefore the main object for this chapter is to justify the selected methods and to provide essential information about the process of this study.

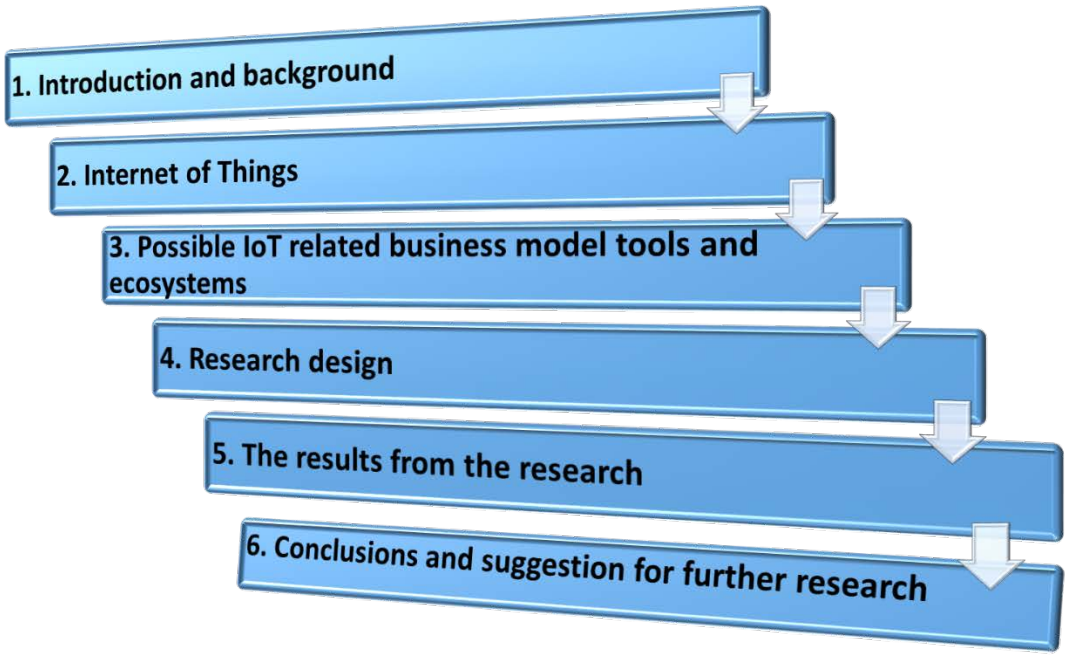

Figure 2. Structure of the study

The empirical part of this study begins from chapter 5 that includes summaries from all the focused interviews conducted mostly on interviewee's premises. Even more importantly, chapter 5 summarizes the results by each research question. Chapter 5.2 aims to answer to research question 1, chapter 5.3 to question 2, chapter 5.4 to question 3, and 5.5 to question 4. Chapter 6, in turn, demonstrates the conclusions as well as addresses the reliability of the research. Furthermore section 6 outlines the suggestions for further research within the topics raised by this study.

2 Internet of Things

This chapter explains the most important terms pertaining within the IoT umbrella. Furthermore, essential differences between eHealth and IoT are described. In addition, a conceptual framework for IoT based business models is introduced, as well as possibilities for IoT solutions in the healthcare sector.

2.1 Explanation of terms

Internet of Things (IoT) is one of the most important future business areas, where global companies and governments see a great opportunity to grow. The hype around IoT enables new startup companies to get funding, which therefore makes it easier for them to innovate breakthrough business models. Morgan (2014) foresees that in the future, a new rule is going to be, "anything that can be connected to internet, will be connected". IoT offers limitless amount of new opportunities and connections, many of which people can't even fully realize today. Mazhelis et al. (2013) envision that the expected rapid growth of the IoT is dependable of common/dominant standards, platforms and interfaces. Therefore it is vital that the developed standards and platforms meets the requirements of a specific IoT domain.

Internet of Things

The Internet of Things (IoT), also labelled as The Internet of Everything and Industrial Internet refers to a new technology model, in which global network of machines, devices and sensors are capable of interacting with each other (Lee et al. 2015, 431-440). Morgan (2014), in turn, defines the IoT as a concept of basically connecting any device with on and off switch to each other or to the internet. It applies to all devices and components with aforementioned capabilities.

The IoT business model benefits from multiple sensors and machines working together. Devices and sensors can be divided into two designs: a simple device that requires client device for internet connection, or an internet-enabled edge device. The actual value within the Internet of Things comes at the intersection of collecting data and utilizing the intelligent analyzed results further on (Wired 2015.)

M2M - Machine-to-machine communication

Before IoT the common term globally was machine-to-machine (M2M) communication. IoT revolves around increased M2M –communication. Generally speaking, when people mention that machines are going to be smart in the near future, they are not necessarily referring to

M2M, but rather to sensors. Sensor is a part of a machine; it can measure, evaluate and gather data (Wired 2015.)

Industrie 4.0

The Term Industrie 4.0 was invented in Germany during a high-tech strategy project and it represents an assembling definition for technologies and concepts of value chain organization. According to Hermann et al. (2015), Industrie 4.0 consists of Internet of Services (IoS), Cyber Physical Systems (CPS), Internet of Things (IoT), and Smart Factory. CPS monitor physical processes and make decentralized decisions within the structured modulars of Smart Factories. Thereafter these systems interact in real time over the IoT with each other and with people. The internal and external services of the IoS are exploited by distinct actors within the value chain. (Hermann, Pentek & Otto 2015.)

E-health vs. IoT

Not to confuse the terminology, e-health is just a small component, for example a single online appointment service, of the whole IoT based healthcare management ecosystem. In addition, IoT based healthcare system could consist of tracking and identification of patients and doctors locations, tracking of patients' health records and tracking of locations of hospital devices et cetera IoT also enables intelligent automatic behavior of some medical devices (Talpur 2013.)

2.2 IoT – figures, key challenges and current status

By the year 2025 IoT can create a huge impact on global Gross Domestic Product (GDP), estimated between 2,7 trillion $ and 6,2 trillion $ according to analyzes from McKinsey Global Institute. (McKinsey 2015) Gartner Institute, instead, forecasts that there can be as many as 25 billion things connected through Internet already in the year 2020. When multiple devices and sensors are interacting with each other it also creates a huge amount of data. That partly explains why 90 % of all the data globally has been created in the past two years and the amount of data is going to increase in a pace that is hard to imagine. (Gartner 2015)

A key to understanding how to create or transform IoT businesses, lies in understanding the value creation and capture processes. From a high-level perspective the IoT can be seen as a digitalization of services from business perspective, and as a cloudification of services from a technical perspective. (Mazhelis et. al 2013, 57). In other words, a single most important thing around IoT is probably how to get right information out of the network of the devices

and sensors, which are interacting together, and then create added value to customers with that data. (Saint 2015, 72-75)

In the business cases historical data and real-time data analysis often needs to be performed together in order to deliver value to companies. The problem is that organizations may find that slow bandwidth speed, or different laws around sharing data globally, may prevent some initial IoT opportunities. Solution to that might be geo-distributed analytics also known as fog computing, which means that data is stored in the same region it was generated in, and subsequently queried at the source. Only the results of the analysis will be send back to company's network. This kind of a process requires data analytics software which is capable of handling big data in real-time at data source. Many software companies worldwide which sell data analytics solutions already offer these types of real-time computing software to global organizations. Despite using decentralizing data storage and analysis, companies still needs a secure cloud where analyzed data can be stored. (Saint 2015, 72-75)

Nevertheless, all the data coming from distinct sensors is worthless without proper infrastructure in place. Therefore applications that are innovated to function as a cloud-based solutions are essential if companies want to get major benefits from their IoT based offerings. Cloud-based applications need to read and transmit the data coming from all different kinds of sensors and cloud enables the applications to work for you anytime and anywhere. (Wired 2015)

To conclude, the Internet of Things industry is still in its infancy meaning that most of the success stories so far have been achieved by relatively small and closed networked ecosystems within a single industry vertical. Generally speaking, there has not yet been any single business model dominating the field, which describes the lack of standards and horizontal solutions crossing the industry lines. Currently the IoT ecosystems are often led by an incumbent dominant player who may not be eager and open to value co-creation with other actors in a certain ecosystem. Even though it seems that IoT is a market in which serving several customer segments or verticals simultaneously with a single market approach is extremely big challenge, the key to resolve that dilemma could be open platforms and devices which will open up opportunities for wide spread services for main stream markets. In the future, there might be a thing, a person and a business interlinked together in the global scale creating huge amount of potential business opportunities to both newcomers and incumbent players (Mazhelis et al. 2013, 85-86.)

2.3 A conceptual framework for IoT based business models

Leminen et al. (Forthcoming, 15-17) have gathered insights regarding distinct business models within an IoT ecosystem. According to their study, a new conceptual framework has been created, which shares different business models into four separate groups. Value chain efficiency model includes a single-purpose application within a closed hierarchical ecosystem. Industry collaboration business model, on the other hand, represents standard solutions on an industry-wide open ecosystem. The healthcare sector itself, requires these open standards and platforms in order to secure the expected growth figures set by separate global research enterprises such as Gartner and McKinsey.

The third business model group, Horizontal market business model, is another open model with a context-sensitive B-to-C and C-to-C applications. Co-creation initiatives and other collaboration initiatives are common ways of operating in these types of business models. IoT can act as an enabler by decreasing costs of implementing new business models with the help of open API's et cetera Therefore in the future almost everyone can start their own business which leads to rapid development of distinctive C-to-C business models. (Leminen et al. Forthcoming, 17-19)

Finally, the Platform business model highlights a platform provider's role in a certain IoT ecosystem. Typically these types of business models are turning again towards closed environments, as the platform provider as a dominant actor is trying to lure its partners and other services and applications providers to its semi-closed or closed interface. (Leminen et al. Forthcoming, 19-20)

2.4 IoT possibilities in Healthcare

Again, Internet of Things is just starting to gain ground in different industries and among the common people, thus in many ways it is still a virgin territory for new applications and uses. For technology oriented companies this provides the possibility to build totally new ecosystems and technologies and thus create new business opportunities. The health sector is considered one of the most potential industry branches for new IoT based solutions as it is expected to grow annually around 50 % from 2010 to 2020 which makes it the fastest growing industry according to the forecasts. The following vertical segments have the highest market potential within the healthcare: monitoring solutions for wellness purposes, as well as for the prevention, diagnostics, and treatment of diseases. (Mazhelis et al. 2013, 14-16)

The monitoring services are believed to grasp a greatest revenue portion within connected healthcare branch in developed markets such as Europe or United States of America. One

reason for that kind of visions is the fact that monitoring services supports other type of healthcare activities like prevention, diagnostics and treatment services. The vast majority of current monitoring devices are connected mainly through Bluetooth to a smart device or gateway. (Mazhelis et. al. 2013, 22-23)

There are several examples of IoT related health studies and business solutions mainly concentrated around monitoring vital life signs remotely and thus helping sick and elderly people staying home and trying to prevent them from being institutionalized. It is likely that in the feasible future different type of injections or cardio simulations could be done remotely. That could save a lot of time in the emergency situations as decisions could be done without the need of being physically in the same room with patient. (Mazhelis et. al, 2013. p. 70)

Talpur (2013) advices that in order to take better advantage of IoT, it is essential that medical enterprises and their employees, not forgetting the customers, entrust the IoT solutions in terms of performance, security, privacy, reliability and return-on-investment. These are some of the key challenges for IoT breakthrough in healthcare industry. The implementation of healthcare management system plays a vital role and thus IoT as a key technology may ease the deployment process when developing modern secure wireless communications.

Talpur (2013) insights that IoT altogether enables an effective way of real-time remote monitoring system of healthcare actors with the help of Radio Frequency Identification (RFID) tags, sensors and actuators. Those RFID tags may be assigned to patients, assets and medical staff as an example. Patient tracking can be applied by offering wristbands to patients that includes RFID tag. In practice, the tags would interact with the healthcare information system, which would automate daily routines such as patients' admissions, transfers and discharges. Furthermore, in administration tasks IoT based solutions may help to streamline processes and minimize harmful incidents. According to Talpur (2013), the aforementioned arguments state that Internet of Things ensures the patient's safety and service quality.

This potential, combined with the current challenges in the Finnish health sector, makes IoT very interesting and important research object for this study. IoT offers an opportunity for discovering information within the healthcare industry, and furthermore, enables the usage of that information for creating added value to customers.

3 Possible IoT related business model tools and ecosystems

The purpose of this chapter 3 is to present multiple business models and ecosystems that may benefit IoT and fasten its growth rate and expansion globally. The next chapters from 3.2.1 to 3.2.4 each present a single business model or a business ecosystem tool. Chapter 3.2.5 summarizes the key points and limitations of the selected business models and ecosystems, introduced in previous chapters, with a single page snapshot. To conclude, chapter 3.3 and its sub-chapters concentrates on ecosystems from different angles.

3.1 Theoretical framework

The theoretical framework of this study is built on four business model and ecosystem tools, which may all be utilized together with IoT based business initiatives: Business Model Canvas (Osterwalder 2010), Magic Triangle (Gassmann 2014), IoT Business Model Framework (Fugl 2015) and Value Design Business Model design tool (Westerlund et al. 2014). Each of these tools are presented and described more thoroughly in the next chapters. IoT related business solutions in healthcare, and more specifically in elderly care, represent a connective subject matter, which integrates all those four aforementioned tools together. The figure 3 below illustrates this theoretical framework.

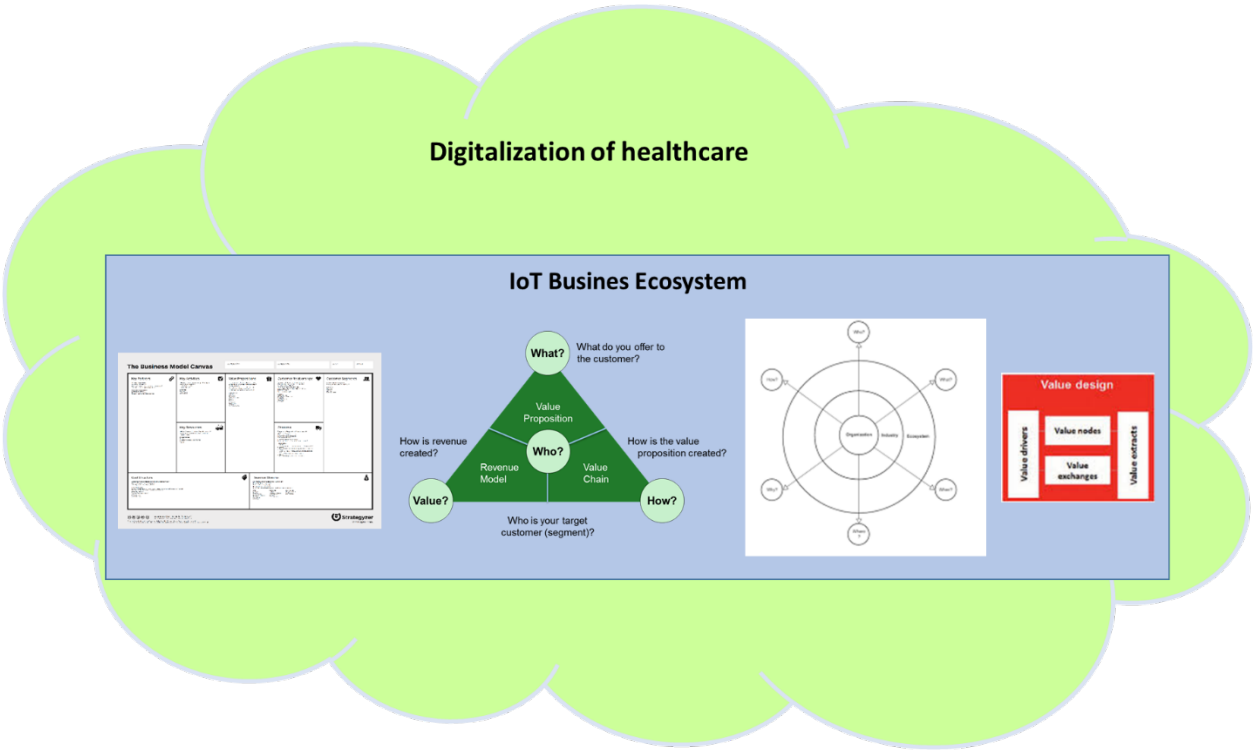

Figure 3. Theoretical framework

3.2 Potential business models

Business model rationalizes how an organization creates and captures value. (Osterwalder et al. 2010, 14-21). Furthermore, a business model is a useful tool to figure out the connections between different actors within an ecosystem. That is not an easy task, though, as typically the business ecosystem boundaries do not share normal vertical industry structure. (Mazhelis et. al. 2013, 59).

Leminen et al. (2015) propose a managerial cognition perspective, where a business model can be conceptualized as a combination of company-related material structures and processes, and intangible cognitive meaning structures consisting of belief systems. These include *reputational rankings* that indicate company's own performance related to its socially evaluated competition, and *industry recipes* that denote the persuasions of the management related to the company's economic, competitive, and institutional logic. Also included are *boundary beliefs* that define the identity of the company within a certain inter-organizational community, and *product ontologies* that link product or service attributes, usage conditions, and buyer characteristics into a hypothetically superior offering on the target market.

3.2.1 Business Model Canvas

Before sketching a business model an organization should have a clear picture of its current and potential customer segments. There might be a need to have separate business models for each customer segment. For example, Amazon can't utilize the same business model for its web store and cloud computing services. On the other hand, business models focused on mass markets don't distinct different segments. (*Osterwalder et al. 2010,* 14-21).

Value proposition

Osterwalder et al. (2010, 22-27) determines value proposition as a concept that separates one company over another by its characteristic of solving a certain customer problem or need. Value proposition may create totally new businesses at the intersections of the current vertical industries or create added value to existing markets. Those values may be qualitative or quantitative. Bruderer (2013) explains that a well thought of value proposition delivers company's unique offering in a clear and inspirational manner to both its customers and employees alike, and differentiates it from the competition. A successful value proposition demands that the company knows its customers' values and needs.

Customer relationships

Customer relationships define the different types of relationships, with which an organizations establishes itself within its customer segment. It is possible to distinguish different type of customer relationships, extremes being co-creation and self-service (*Osterwalder et al. 2010,* 28-29). In order to better understand and manage organization's customer relationships, it may be beneficial to acquire a Customer Relationship Management (CRM) tool. Such software allows company to gather and govern massive amounts of data and thus make use of it when carrying out distinct strategies. (Bain & Company 2016)

Revenue streams

Revenue streams comprises the different methods organization utilizes to generate revenue. Pricing mechanism may fluctuate from one revenue stream to another. A business model could include two types of revenue streams: transaction revenue represents one-time customer payment while recurring revenues result from ongoing payments. (Osterwalder et al. 2010, 30-33).

MaRS (2009) introduces four revenue types that form a basis for most revenue models:
1. Recurring revenue, in which continuous, recurring revenue is generated by, for example, binding to long-term service contracts of software.
2. Transactional revenue that is based on predictable sales of goods.
3. Project revenue that is generated by individual projects that hopefully lead to new projects with satisfied customers.
4. Services revenue, the least attractive type of revenue, is based on selling service time, and hence is easy to compete on.

Key activities, resources and partners

An organization needs to have key resources, key activities and key partners in order to succeed. Key resources, which may be physical, intellectual, financial or human, may be either owned or leased by the organization or obtained from most significant partners. Key activities includes the most important actions organization must take in order to operate profitable. Partnership network defines all the essential partners that make a significant impact on business model. (*Osterwalder et al. 2010,* 34-39). Cowan describes key activities as a crucial matter in order to deliver the business proposition and elaborate the business plan to actually work. The Business Model Canvas discloses three core business types: *product*, *scope* and *infrastructure*. They all have the habit of sharing equal types of key resources.

After defining the key activities and resources, the next step is to decide if partners can be responsible of some of those.

Business Model Canvas

Those aforementioned components form the foundation of Business Model Canvas (BMC), a handy tool invented by Alexander Osterwalder back in 2008. BMC allows user to paint pictures of new or existing business models. The tool works best when it is printed on a large surface which provides an opportunity to start sketch and discuss the business model elements with Post-It notes or other similar types of instruments. (Osterwalder et al. *2010,* 42-45). Benefield (2014) states that the nine building blocks included in the Business Model Canvas helps an organization to understand their current business as well as fill the gaps and create totally new opportunities. A solid and well-functioning business model can disrupt existing actors in traditional markets.

> *"The Business Model Canvas has helped several healthcare organizations in the Netherlands to make the move from a budget driven governmental institution to an entrepreneurial value-adding organization."* (*Osterwalder et al. 2010,* 51).

Real innovations often born in unstructured circumstances that resemble systematic chaos. Business model planning is not about looking back or looking to competitors. Rather, the business model innovation is about breaking the current standards by designing models that challenges unsatisfied, new or hidden customer needs. (Osterwalder et al. 2010*,* 134-145). Implementing a new business model within an incumbent enterprise may be extremely difficult. It may encounter resistance internally as it may cannibalize enterprises' current business models. The totally new business model might either be merged to enterprises' current offerings or it needs to be separated to its own entity. (Osterwalder et al. 2010, 232-239).

Figure 4 presents the Business Model Canvas tool form by Osterwalder et al. (2010), which provides an opportunity for sketching and discussing the business model elements in a visual and easy to comprehend manner.

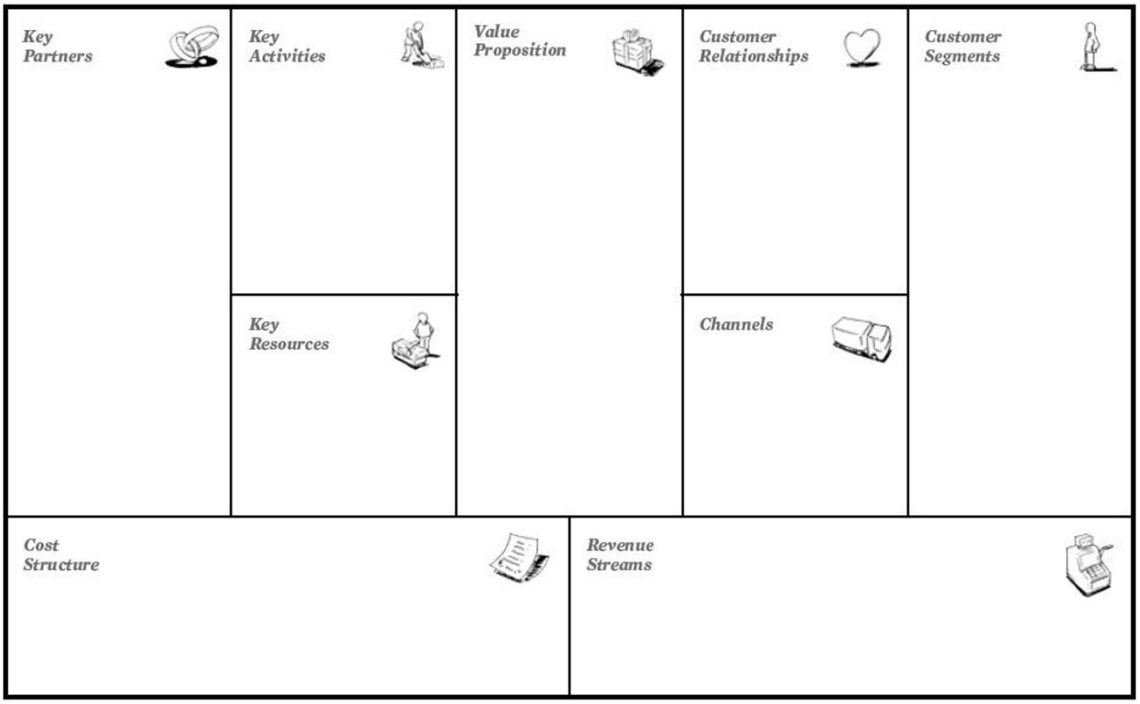

Figure 4. Business Model Canvas (Osterwalder et al. 2010)

Unique design process

Business model design process is unique for each organization and depends on its challenges, obstacles, desires and critical success factors. Notwithstanding there are few principle root causes why an organization starts business model innovation process: to satisfy existing but unanswered market needs, to bring new technologies, products or services to market, to improve, disrupt, or transform an existing market with a better business model or to create an entirely new market. (Osterwalder et al. 2010, 244-259).

SWOT-analysis

It can be beneficial to combine traditional SWOT-analysis (*Strengths, Weaknesses, Opportunities and Threats*) together with Business Model Canvas. Strengths and weaknesses in SWOT analyzes the organization internally while opportunities and threats concentrates on its surrounding environment. In the end combined analysis yield two results, where the organization is now (strengths and weaknesses) and what kind of possible trajectories (opportunities and threats) exist from the organization's point of view. (*Osterwalder et al. 2010,* 212-225).

MaRS (2013) describes SWOT analysis as being a very commonly used strategic framework in business that is easy to understand and offers a practical basis for evaluating strategic

choices. Moreover, it can be applied to a product, business unit or whole company, as regards strategic business goals.

Limitations

The Business Model Canvas is not limited to for-profit organizations. It can be easily applied for non-profit organizations as well, though it is essential to recognize the distinct focuses they have comparing to corporate companies. The risk for the non-profit organizations can be the desire to treat the third-party financer as a customer instead of the actual end-customer. (Osterwalder et al. *2010,* 264-265). In addition BMC examines business model from a single legal entity's point of view, and as such does not bring much added value for a whole ecosystem perspective.

3.2.2 Magic triangle

Business success in the health sector, as in other lines of business alike, leans on a strong business model that is carefully selected to realize a company's business idea and vision. Gassmann, Frankenberger and Csik (2014) introduce 55 business models to help companies choose and implement a competitive strategy for their line of business. Based on their long-term empirical research, the Business model navigator is designed to work as a toolkit for developing a winning business model for any company. In their research, the authors discovered that over 90 % of all business model innovations recombine existing concepts from other industries.

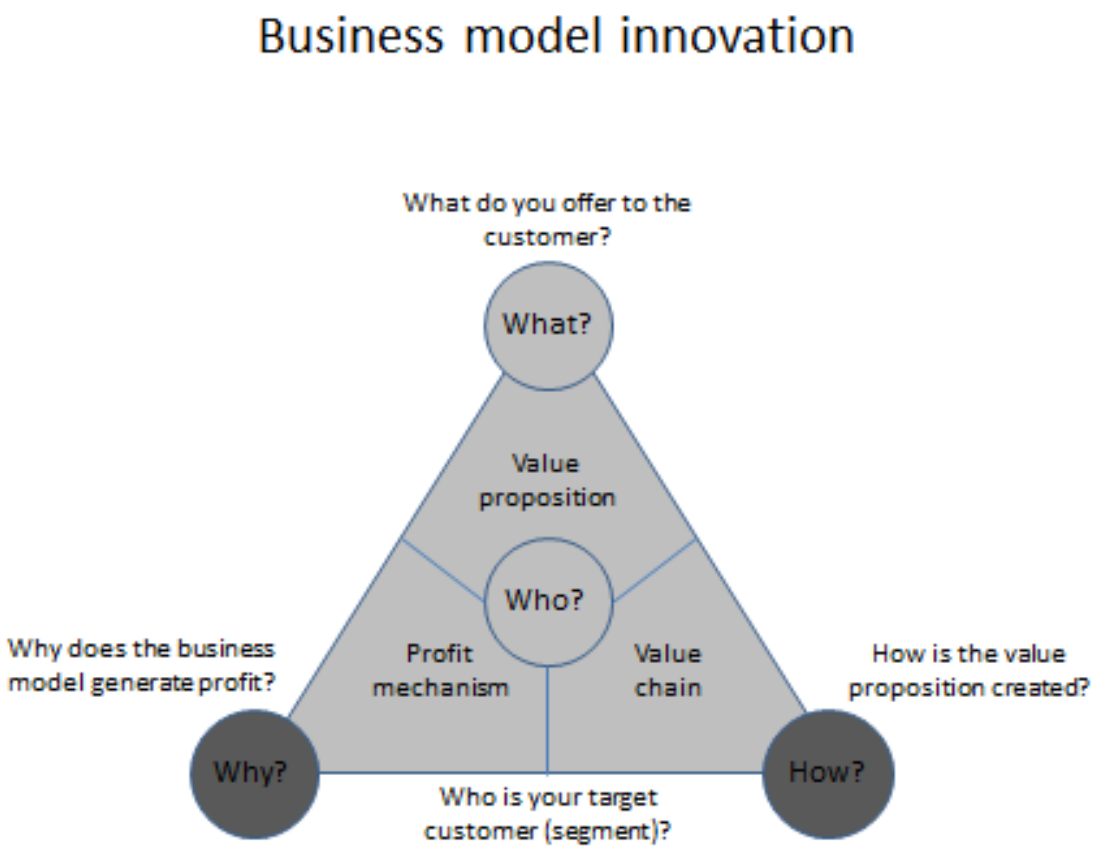

Figure 5. Business model innovation (Gassmann et al. 2014)

Gassmann et al (2014) describe the elements of a business model in a diagram called the 'magic triangle', depicted in figure 5 above. It defines the elementals of any business model by addressing who are the customers, what is being sold, how the offering is produced, and why the business is profitable. The who and what address the external aspects of the business model, whereas the how and why address its internal dimensions. Moreover, the significance of business model innovation compared to product or process innovation derives from the fact that it prominently affects at least two of the four components of who-what-how-why. According to Gassmann et al. (2014) a successful business model innovation creates value for customers while it captures value for company.

Frankenberger & Csik (2014, 132) describe the digitization business model as being one of the most significant models that is shaping the ways of making business everywhere. It signifies transforming an existing product or service into a digital variant. Rather than merely allowing an existing business to be reproduced online and various business processes and functions relocated to the internet, it can also pave way for entirely new business ideas. Digitization also enables manufacturers to utilize intelligent and networked physical products and the collected sensor data (IoT) to provide new software-based business opportunities.

3.2.3 IoT business model framework

Fugl (2015, 6) describes the current evolution stage of IoT concept as being challenging for many traditional non-technical companies that, whilst seeking to create growth and optimization using Cloud and IoT based solutions, fail to grasp the business opportunities that emerge with IoT. Consequently, instead of evolving their business model to meet today's opportunities, they wither, keeping their business model at a static level.

According to Fugl (2015, 1) an IoT business model framework strives to incorporate the ecosystem synergies, stages, and business strategies to provide companies with a flexible approach that takes all essential aspects of the IoT concept into perspective. In doing so, Fugl aims to better outline the complexity of the overall IoT value chain; the organization, industry and ecosystem, taking into account the instability of the highly innovative environment.

Illustrated business model tool

Furthermore, all value creation and capture activities and flows, as well as the challenges and barriers associated with them, are intended to be clarified by addressing the “Who?” “What?” “When?” “Where?” “Why?” and “How? in the value chain. The object is to provide companies with a tool with which to understand, analyze, communicate, and manage strategic-orientated choices surrounding the IoT concept, and throughout the ecosystem. This tool is illustrated in figure 6. Besides providing an encompassing overview of the value chain and its components, the flexible model can also be used to highlight the essential components from a single company's perspective.

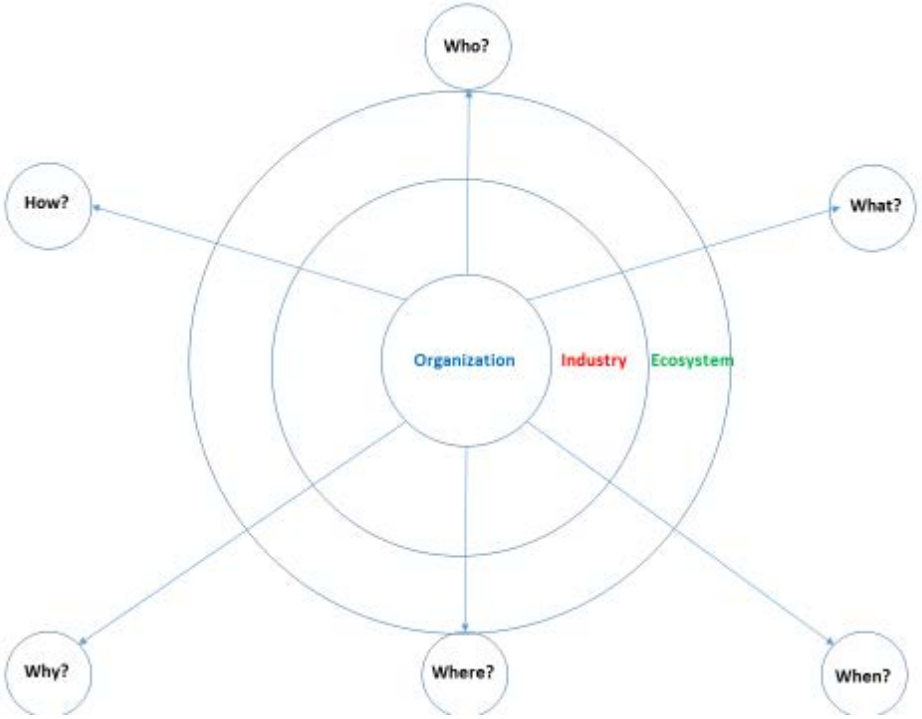

Figure 6. Proposed IoT business model framework (Fugl 2015)

IoT from a business perspective can be abstracted as follows:

> *"The Internet of Things and services makes it possible to create networks incorporating the entire manufacturing process that convert factories into a smart environment. The cloud enables a global infrastructure to generate new services, allowing anyone to create content and applications for global users. Network of things connects things globally to maintain their identity online. Mobile allows connection to this global infrastructure anytime, anywhere. The result is a globally accessible network of things, users, and consumers, who are available to create businesses, contribute content, generate and purchase new services"* (CERP-IoT 2014, 9).

IoT value chain's layers

Fugl (2015, 27) explains that the IoT value chain's different layers consist of distinct product or service categories, with companies competing at either one or multiple layers. Figure 7 illustrates an overview of an IoT ecosystem and value chain, portraying also the various industrial areas that are already affected by IoT today. According to Fugl (2015, 28), a single company's positioning in value chain integration is largely determined by the technology and service provider choices it makes. Moreover, by choosing multiple technology and service partners, a single company is in fact becoming part of multiple, and also competing ecosystems.

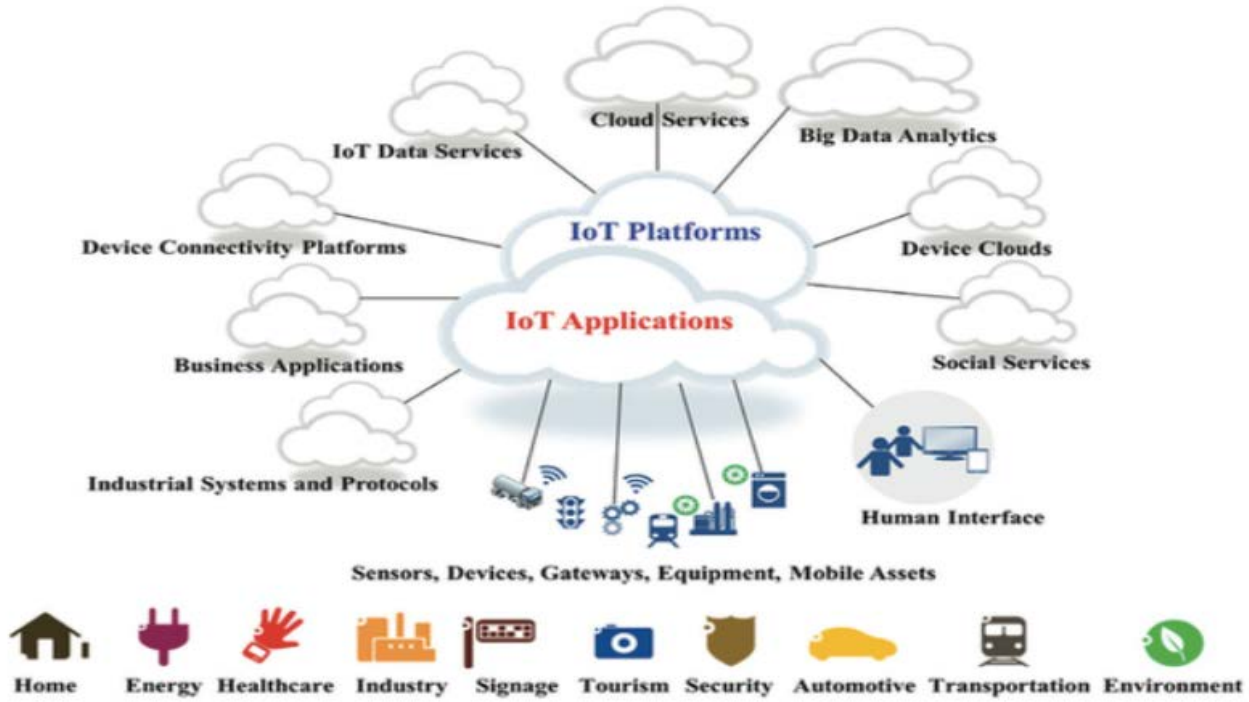

Figure 7. Internet of Things value chain integration (CERP-IoT 2015, 16)

Fugl (2015, 28), has identified three overall business strategies within IoT, namely, Enabler, Engager and Enhancer, which explain the business opportunities and challenges on the three levels of the IoT value chain; the organization, industry and ecosystem. Enablers are the actors that develop and implement the underlying technology. Engagers, on the other hand, design, create, integrate, and deliver IoT services to customers. Enhancers bring their own value-added and unique to IoT services to the mix. These three strategic categories, as explained by Fugl (2015, 30), incorporate or interact with the main stakeholders, namely, vendors, suppliers and customers/end users.

3.2.4 Business Model design tool for an IoT ecosystem

Westerlund et al. (2014) describe an ecosystem business model as being composed of value pillars anchored in ecosystems. The focus is on both the company's and the entire ecosystem's methods of creating and capturing value. Moreover, three major challenges of designing ecosystem business models for the IoT are presented by them. The first one is the diversity of objects, which refers to the lack of standardization of interfaces with connected objects. The second challenge is the immaturity of innovation, which means that many IoT based technologies and innovations are not yet in product stage. The third challenge is the unstructured ecosystems, meaning that the participants and their roles are yet to be

determined in the evolving ecosystems. In the ecosytemic perspective it is vital to understand the interdependency of the companies that are operating in the same ecosystem.

Leminen et al. (2015) explain that changes in industry boundaries and service architectures require the development of value designs, i.e. ecosystem business models that consider entire IoT ecosystems. They argue that existing business model templates and tools provide little help for the developing ecosystems that lack many actors. These existing models have been designed for incumbent actors, and are thus less suited for the interdependent nature of new ventures partnerships that are evolving in the same ecosystem. Hence the ecosystem view to business models helps to understand possible IoT business models.

Value Design Pillars

Westerlund et al. (2014) propose a Business model design tool that considers the ecosystemic nature of the IoT (Figure 8). Furthermore, they propose that "value design" might be a more suited term when discussing business models in ecosystems, as business models are widely understood to be about value creation and value capture. *The value drivers* in ecosystems promote the birth of an ecosystem with the purpose of generating value, realizing innovations, and making money, and consisting of both individual and shared motivations. Westerlund et al. (2014) argue that in a impartial, win-win ecosystem respect for the objectives of other actors is required in order to form long-term relationships.

Value nodes, on the other hand, comprise of various actors, activities, or processes linked with other nodes in order to create value. These value nodes may include independent actors such as smart sensors, pre-coded machines, and connected intelligence. Furthermore, they can be groups or networks of organizations, or even groups of networks. (Westerlund et al. 2014). Bucherer (2011), in turn points out that when designing new IoT business models, the crucial matter is to utilize the exchange between nodes in the IoT network and to combine that with a win-win information exchange between the stakeholders in the ecosystem.

Value exchanges, in turn, encompasses the exchange of value by different methods, such as resources, knowledge, and information. The value exchange appears between and within distinct value nodes in a certain ecosystem. In addition, these exchanges are defined through different value flows. Moreover, these flows despict the activities that take place in the business ecosystem for the purpose of creating and capturing value, whether it be exchanging resources, knowledge, money or information by different means.

According to Mejtoft (2011, *672-677)*, IoT consists of three layers of value creation: manufacturing, supporting and value co-creation. For instance, manufacturing might benefit

from the possibility of tracking goods. In supporting layer the collected data can be used to create value to both the industry and the customer. Value co-creation means that the connected network of devices and sensors can think for itself.

Value extracts depicts a part of an ecosystem that extracts value by showing results that can be monetized, as well as the substantial nodes and exchanges required for value creation and capture. This enables decision makers to focus on, for example individuals, single activities and automated processes. Furthermore, organizations, groups and networks, and value flows between these nodes are presented. Value extract thus helps to define the core value and its underlying aspects on the ecosystem. (Westerlund et al. (2014).

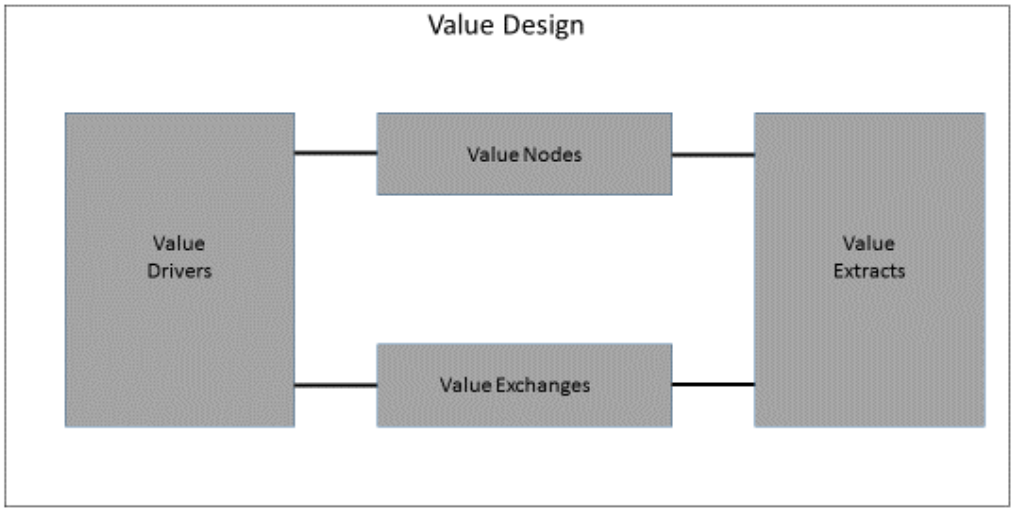

Figure 8. Key pillars of a business model design tool for IOT ecosystems (Westerlund et al. 2014)

3.2.5 Summary of selected business model tools

This chapter aims to summarize the aforementioned business model tools with their key points and limitations. Furthermore the idea is to summarize the applicability for different sized companies in a possible IoT ecosystem. The table 9 below illustrates the key findings from distinct business models in which the key points have been pinpointed to a single page chart.

Chapter Number:	Business Model Type:	Key Points:	Limitation / Applicability:
Chapter 3.2.1	Business Model Canvas by Osterwalder	• Single page snapshot of new or existing business model • Easy to adjust, sketch and reiterate	• Not always ideal for startups • Focuses on a single company point of view. • Offers effective way to assess the vitality of business idea
Chapter 3.2.2	Gassmann's Magic Triangle	• Suitable for all business types and industries • Easy questions: Who, What, Why and How	• Doesn't consider the value exchange between distinct ecosystem actors. • Easy to perceive and adopt
Chapter 3.2.3	IoT business model framework by Fugl	• Incorporates the ecosystem synergies, stages, and business strategies. • Provides the organization, industry and ecosystem views to help forming a strategy	• Complex to master all aspects • More targeted to incumbent actors • Pervasive approach to business model innovation
Chapter 3.2.4	Value Design – business model design tool	• Value drivers, value nodes, value exchanges and value extracts help to examine value creation and value capture in an IoT ecosystem • Helps to perceive win-win value exchanges in the ecosystem	• Requires understanding of the actors and dynamics in the ecosystem (more complex for startups) • A refined way to examine value exchanges and interdependencies between ecosystem actors.

Table 1. Summary of selected business models

3.3 Business ecosystems

This chapter describes the ecosystems by comparing biological and business ecosystems, and then expands to depict business models. Furthermore, the IoT and ecosystem and their connection to each other have been pinpointed. To conclude, an educated guess, rather than an industry specific list of the IoT ecosystem actors, is presented.

3.3.1 Business versus biological ecosystems

The biological ecosystem consists of different organisms living close to each other. Interactions exist between those organisms and also with physical environment, which may set restrictions to the organisms. A business ecosystem therefore has its foundation on the biological ecosystem. In a business ecosystem a separate legal entity, normally a single company, represents the equivalent of an organism. (*Peltoniemi 2005*, 54-55)

According to Moore (1999), a business ecosystem is *"a network of buyers, suppliers and makers of related products or services plus the socio-economic environment including the institutional and regulatory framework."* Besides the ecosystem core, also owners and other stakeholders, as well as competitors are included in the business ecosystem. Organizations in the business ecosystem need to interact and co-create. The survival of each actor most likely depends on others, thus the organization's everyday life consists of balancing between cooperation and competition.

Lewin (1999, 198-199) asserts that biological and business ecosystems share many attributes, however according to him, the biggest distinction between those two ecosystems are the human behavior. That is to say, humans can make conscious actions, while in the biological ecosystem everything is based on unconscious behavior. Nonetheless, Lewin addresses that by understanding the rules of nature, the possibility to understand how companies work and interact within the ecosystem, increases.

Sometimes it may be difficult to perceive a certain business ecosystem, since the determination of a level, where an interaction stops between organizations, is extremely difficult. The key is to thoroughly research when such interconnections exist and that those entities can be interpreted to belong to a certain business ecosystem. Peltoniemi (2004, 64) describes the typical characteristics of a business ecosystem in the following figure 9.

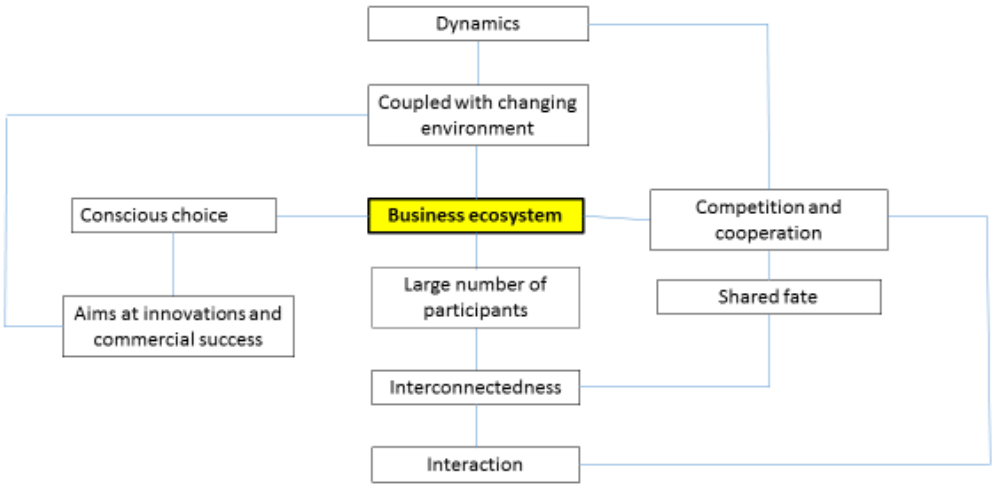

Figure 9. Typical characteristics of a business ecosystem (Peltoniemi 2004, 64)

At the organization level a single company aims to innovations and commercial success while its interconnectedness to other organizations may prevent it from reaching the planned targets. Therefore an organization can aim to a certain direction but as an outcome the impact of other members of the ecosystem could change or prevent this direction. (*Peltoniemi 2005*, 64-65)

On the other hand, at the population level interconnectedness leads to shared fate, which means that separate entities within a certain business ecosystem are dependable of each other. Both private enterprises and public actors may belong to the same business ecosystem. Therefore it is essential to realize that an ecosystem together with its environment comprises a specific couple, which represents such unpredictable dynamics. (*Peltoniemi 2005*, 64-65)

The most vital roles in a business ecosystem are labelled as *keystone*, *dominator* and *niche players*. Keystone player is the center pillar who increases the chance of survival for all players in a certain ecosystem. Dominator instead eliminates the room of other actors in order to increase its own importance. They are usually significantly larger than keystone players. A niche player captures a small specialized portion of the whole ecosystem and focuses on developing differentiated set of capabilities. They are usually individually small but together consist of large and invaluable portion in the ecosystem. (*Peltoniemi 2005*, 47).

3.3.2 IoT and ecosystems

Currently the IoT field is specified by multiple co-existing and competitive products and platforms as well as proprietary standards and protocols. The elements of the solutions are therefore hardly comparable, generating markets in which the prices of separate components are high. The likely widespread implementation of IoT businesses creates different sorts of IoT ecosystems in which each constructs its own community of interacting organizations and individuals in their socio-economic environment. Within the ecosystem, actors simultaneously compete and cooperate between each other by exploiting core assets in the interconnection of physical world things and virtual world internet. (*Peltoniemi 2005*, 8)

Through results from IoT business models themed Delphi study, Leminen et al. (2014) suggest that even though there have been attempts to transform from IoT applications to vertical industries towards horizontal applications spanning multiple industries, many of the current innovations are still actor or industry specific, and thus fail to work alongside. Secondly, both the business users and consumers are uncertain about the actual benefits and application areas regarding emerging IoT technologies. Furthermore, it seems that comprehensive and adaptable IoT solutions and ecosystems require tighter network relationships than what is seen currently.

According to Leminen et al. (2014), the results of the Delphi study indicate that industry solution providers will most probably have leading positions in the emerging business cases. Furthermore, health guidance services and health-related products and services are among the most prominent lines of business to utilize IoT based solutions. Moreover, the general opportunities include that separate

> *"industries like health services and housing may be able to offer joint services related to smart home services building on IoT technologies. Business models need to take account and motivate all actors for exploiting the data in multiple ways. An actor who gathers the data is the most viable choice for managing the network. A number of actors require the possibility to receive and refine data that is gathered with the help of IoT technologies. It is crucial that the end-customer wants to pay for the products or services; only this makes mass-markets come true. Networking and offering wider total solutions with partners are of the utmost important. The drivers of IoT include efficiency (including, e.g., energy efficiency, cost efficiency), need for anticipative maintenance or for "total" services or solutions. IoT solutions and ecosystems require networking and a business model, which motivates all the actors of the network" (*Leminen et al. 2014.)

IoT requires open, scalable, secure and standardized infrastructures in order to grow as rapidly as expected. There is currently ongoing shift from closed private ecosystems towards open networked ecosystems. At the moment IoT field is dominated by B-to-B solutions but the amount of B-to-C solutions are increasing at the background. This study will concentrate on B-to-B type of IoT solutions. (Bucherer et al. 2011).

Open application programming interfaces (API) are needed if the desired outcome is a rich ecosystem which includes, not only keystone and dominant players, but also significant number of smaller niche actors such as startups. Therefore the paradigm shift from closed to open ecosystem is welcomed. While technological gaps and barriers between distinct entities within a single ecosystem are rather easy to fix, the change of actual processes and mode of operation may be more complex issue. Thus the aforementioned cooperation between the members within an ecosystem, is extremely vital. Co-creation and different types of common workshops may ease the transformation of current processes.

Considering the aforementioned views, a generic business-to-business IoT ecosystem may comprise of following actors:

- Platform providers
- Solution providers
- Infra and network providers
- Software developers
- Device and/or sensor manufacturers
- Data storage provider (local server or cloud computing storage)
- Consulting companies
- Analytical capabilities and/or software providers
- Brokers
- Customers

3.3.3 New disruptive healthcare innovations

Accenture's (2016) research describes how life science companies prepare for disruptive forces emerging in a broader healthcare ecosystem by redefining their existing strategies and operating models. According to Accenture, the convergence of scientific breakthroughs, rapid growth in volumes of health and digital data and advances in digital technology, together with global changes in healthcare funding and the aging of societies, requires new definitions of healthcare and how it will be delivered and experienced in the future. *"A new order is emerging in the healthcare industry, focused on the patient, in which financial incentives*

will be linked to the value a product delivers, and not just the product itself," states O'Riordan of Accenture (2016).

Devonas (2015) in turn, sights disruptive innovations acting as a warning for incumbent players and as an opportunity for agile startups. However, disruptive business models transform industries. Disruptive businesses often create value by repeatable and replicable processes, which help new agile startups to operate at lower price level than established organizations. The latter may find it difficult to invest heavily on new services or products for fear of cannibalization of its existing business models. Eyring (2012) amplifies that through business model innovation, organizations should review their value chains and renew their current processes. By re-innovating business models, the possibility to reduce costs and improve care increases drastically.

Accenture's O'Riordan and Elton (2016) outline four emerging business models centering on patient outcomes and value. *Lean Innovators* utilize the best practices of generics companies' efficient manufacturing and lean supply chain and challenge existing cost structures and operating models. *Value Innovators*, on the other hand, are product-centric scientific innovators aiming to improve outcomes for patients and health systems. *Around-the Patient Innovators*, in turn, focus on integrating therapeutics, devices and services with clinical management processes. *New Health Digitals* possess economics grounded in digitalization, global scale, and the large ecosystem of apps, technologies, devices and the cloud.

4 Research design

This chapter introduces the research methods of this study. Furthermore, we state arguments for the selected research methods used in our research. A comprehensive conception of relevant theoretical framework and research methods is required in order to confine the subject matter correctly.

4.1 The research methods

According to Ojasalo, Moilanen and Ritalahti (2009, 3), on ever faster changing operational environments the ability to predict changes and to innovate have become significant competitive factors. Furthermore, the role of customers is becoming more important, as their willingness and capabilities to participate in the development process increases. Companies require constant development work in order to enhance their profitability, to enable business growth, to the development of new commercial products or services, to better understand changing customer needs, to organizational problem solving and so forth. (Ojasalo et al. 2009, 12) New business and revenue models are fine examples of means to create new kinds of customer needs and business opportunities. One example of these are the aforementioned disruptive innovations that shake and potentially reshape established business environments.

Understanding the research problem and the industry

Ojasalo et al. (2009, 25) state, that it is essential to find the right standpoint for the development research, which is derived from the existing theoretical background. This consists of the relevant theoretical concepts and their interdependencies, which are defined and explained in order to ground further narrowing of the research problem, and best possible approach and methods to study it. Vilkka (2009, 63-68) states that the choice of a research method should be based on the following question: What kind of information this research wants to produce? The choice of research method should not be based on personal preferences, but rather on the research problem, research questions and the desired knowledge guiding the selection of research method. Furthermore, it is essential to form a strictly limited research problem and questions, as otherwise the research can become overly broad. Thus the finalized report ideally offers something for everybody without going too deep below the surface with any particular theme. (Vilkka 2009, 60-61)

Understanding the industry and the operational environment is crucial to any development projects. Ojasalo et al. (2009, 29) describe common challenges facing an entire industry as being entry of foreign competitors to the market, changes in legislation and regulations, or changes in the purchasing power or consumption behavior of consumers. Getting to know the

focus industry also helps to understand the everyday processes and inherent challenges of its actors, and to drive the development work from this basis rather than merely adapting theory models into practice. This knowledge of the industry can be obtained from industry statistics, reports and various public surveys and are today often accessible via internet.

Qualitative research method

Research methods can roughly be divided into quantitative and qualitative types. Qualitative research method concentrates, not only on finding similarities from the research data, but also on discovering discrepancies from the data. Generally speaking, one object of a research is to reveal significances that people give to their activities. The other object is to describe an understanding horizon where people interact by analyzing people's desires, beliefs, values, views and ideals. The primary target for a qualitative research, therefore, is not to be as objective as compared to using quantitative research methods. (Vilkka 2015, 66-67) The research method in this research will be based on focused interviews and as an outcome the results from the interviews shall be qualitative.

Vilkka (2015, 118-120) explains that one of the idiosyncrasies in qualitative research methods is the fact that they are not striving towards finding any absolute truth. Instead the purpose of the research is to uncover some latent views, attitudes and practices behind everyday operations and functions that may not be visible to naked eye. Qualitative researches should therefore concentrate on different cultural, social, historical and professional phenomena associated with the subject matter.

Quite often research sample in qualitative research methods will be collected in some form of an interview. Focused interview is a most common type of a research interview. It is also called a half structured interview. (Vilkka 2015, 122-124)

Case study as a research strategy

Ojasalo et al (2009, 52) describe case study as being a useful research strategy, when the objective is to produce viable development ideas and proposals. It aims at producing profound and actual information about the case subject, whether it be a company, a part of it or some process or trend that is studied. Case studies often find answers and understanding to question such as "how?" and "why?". The emphasis is on observing and studying local, temporal and social situations and interconnections, rather than making statistical generalizations.

4.2 Research interviews in general

Ojasalo et al. (2009, 95) explain that interview is a practical way of collecting information because it allows meaningful and even profound information gathered swiftly. Furthermore, it enables the interviewees to bring forth their personal expertise and insights unlike any official document produced by the focus organization. This is particularly beneficial when the subject matter is relatively new and lacking comprehensive studies.

Hirsjärvi & Hurme (2014, 60) explain that one possible solution to the problem "How many interviewees should one have?" could be using method known as saturation, in which new interviewees are collected until no new aspects can be found by adding another one. This method requires that the researcher is able to conclude when enough material has been collected to form significant results and deductions. There are, however, possible problems with this way of thinking, as Hirsjärvi & Hurme (2014, 60) point out. Firstly, much of the ability to saturate the research problem depends on the sophistication of the researcher to find new aspects and further questions for the research. Secondly, every interview situation is unique and, thus it is difficult to foresee what kind of new information can be obtained with each new interview.

Ojasalo et al (2009, 97) define interviews as being interaction, in which mutual trust and understanding has to be gained in order to make most of the interview. The interviews are advised to be recorded and later transcribed to written form for analysis and conclusions. This enables the participants to focus on the discussion during the interview, and to make the discussion more profound through open discussion. In a half-structured, qualitative interview the questions are formulated in advance, but they need not to be followed punctually or in a particular order. Vilkka (2015, 137-139) points out that transcription should correspond with the interviewee's opinion, which therefore means that no modifications to actual content is allowed.

Vilkka (2015, 125) emphasizes that for its nature qualitative research method should also be emancipatory, which means that the research should also increase the subject matter understanding of interviewed individuals. The most important task for interviewer is to follow the content of the interview and keep the interviewee within correct theme and context. Moreover, an important criteria for choosing the interviewees is that the interviewee has both expertise and personal experience from a researched subject. (Vilkka 2015, 125-135)

4.3 Interviews for this research

Hirsjärvi and Hurme (2014, 48) outline that instead of using detailed questions, the focused interview is built around pivotal themes of the research. This enables the interviewees to bring forth their personal views, interpretations and meanings to the themes at hand. Also new meanings are also provoked and deepened with the interaction of the researcher and the interviewee. According to Hirsjärvi and Hurme (2014, 48), the focused interview is a semi-structured interview that lacks the precise form and questionnaire of a structured interview. However, as the themes are selected beforehand and are same to all interviewees, it is not entirely free as depth interview.

As the subject matter of this study is relatively new and research material thus limited, it was decided to base the research on selected focused interviews with professional people representing broad spectrum of the possible healthcare sector. In this sense, our research represents a form of development by research, in which multiple sources of information and professional views are critically examined and used to outline possible IoT based business models and an example of a conceivable ecosystem. The objective was to learn about their different perspectives on possible IoT solutions and ecosystems for elderly care in Finland.

Group interview could have been suitable solution to gather insights for IoT related elderly care topics. In this case, though, it would have been extremely difficult to get all the intended individuals around the same table. (Vilkka 2015, 125)

Most of the interviewees were conducted in face-to-face meetings and recorded with digital recorder. Three of the interviews were conducted as a telephone interview, and also recorded with digital recorder. All of these interviews were conducted with a preplanned questionnaire designed and customized specifically to each interview.

4.3.1 Timeline of the research

The focused interviews of this research were conducted in fall of 2015 and in the spring of 2016. As the research is a further research on a previous study, some of the interviews were from that particular 2015 research. The arrangement of the new 2016 interviews was designed in a manner that would benefit the further learning of the selected themes, as the research progressed. It was decided to begin this new set of research interviews with the validation of last fall's findings from a Helsinki based public elderly care center.

In the next phase it was considered useful to obtain views from the private sector elderly care providers to supplement findings from previous interviews. The following interviews were

conducted with professionals from different facets of the industry and perceived healthcare ecosystem. Each interview was carefully transcribed and then summarized in English to give new insights to selected themes. Further analysis of the research interview findings and formation of the research was done during summer of 2016.

4.3.2 Research interview form

While executing qualitative research method, all the questions where interviewee could answer "yes" or "no" should be avoided. Researcher should know the target audience and their ambience before submitting empirical questions. Also background information plays a vital role for researcher to understand the mindset and worldview of an interviewee. Furthermore, a well-planned plot helps to get the best possible information out of the interviewee by mitigating the stress he or she experiences. (Vilkka 2015, 128-134)

For this research, each interviewee was given an individualized questionnaire beforehand in order to give them possibility to orientate themselves to the interview. Each time the questions were meticulously prepared for each interviewee factoring in their background, area of expertise and the subject to which their views were wanted. The questionnaire included themed open questions to guide the conversation within desired theme and context. Appendix 1 includes the research topics used in the interviews.

4.3.3 Interviews in brief

A total of thirteen persons were interviewed, all of whom share some basic thoughts about the health sector and its challenges. However, when entering detailed-level discussions, their comments and opinions were more diverse. That served the main idea behind this study as the object was to reach heterogeneous people with diverse backgrounds in order to get a clear picture about the possibilities IoT can offer to health business.

Helsinki based public elderly center

Total of three interviews were conducted in a Helsinki based public elderly center for elderly people on 23th of September, 2015. The first interviewed person was the head nurse in this elderly center and second in charge after the director. The second person to be interviewed was a ward nurse in the G-building, and in charge of a ward for temporary occupants. The third person to be interviewed in the elderly center was another ward nurse and in charge of a ward for temporary occupants in G-building, as well as a crisis unit in the third floor of G-building.

The objective of these interviews was to try determine the possible needs for digitalization and IoT solutions for this particular elderly home. The questionnaire included several questions prompting interviewees to describe the present state of daily operations and the possible problems that might benefit from new technological solutions. The object for these three interviews was to learn both managerial and day-to-day work aspects from the experiences of these elderly care professionals.

As a start point of this study it seemed valuable to get a confirmation from the elderly center's executive team that our assumptions made for the 2015 IoT project were reasonable. Therefore we decided to interview their CEO and that interview was conducted on 25th of February 2016 on their premises. At this point the questionnaire was still a slightly more concentrated towards this elderly center's issues and the big picture was intentionally left in the background.

Telecom vendor's Innovation Advisor

Innovation advisor of a Telecom vendor was interviewed on 29th of September 2015. The Innovation advisor has a long and globally oriented working career in this telecommunications corporation, and he has obtained considerable IoT solution expertise within the company. This made him a valuable asset for this case project and possible following projects concerning IoT. The purpose of this interview was to gather valuable information regarding future IoT ecosystems in healthcare. Many interesting topics were handled, such as service provider-, platform-, connectivity- and pricing related matters.

CMO of the city of Helsinki

The last interview regarding the 2015 IoT project was conducted as a phone interview on 7th of October 2015 and the interviewee was CMO in health and social agency of Helsinki service area. This CMO's expertise was recommended by the staff at the aforementioned elderly care center due to her past association with them and her involvement with the initialization of the ELSI Smart Floor project. Her valuable views of elderly care and resource optimization were considered valuable for this project. This was the first focused interview from the customer side where the discussion was rather a wider nationwide elderly care oriented than concentrating on this particular elderly center.

Development and Quality Director of Private elderly care provider A

The views from private elderly care sector were also considered valuable for this study. Therefore the next person to be interviewed in 2016 after CEO of the public elderly center

was Development and Quality director of Private elderly care provider A. This particular interview was conducted on 30th of March 2016 on customer's premises. The object of this interview was to get opinions from a private sector actor from the business pains they have on their daily routines and furthermore, how technology may help to solve those business pains. In addition the purpose was to clarify if the development targets in the private sector differ when comparing to the public sector.

Technical Director of an Equipment provider

Solution provider perspective was considered essential for this study, and therefore the Technical Director of an Equipment provider was interviewed on their premises at 13th of April 2016. The main purpose of this interview was to get a more clarified picture from the solution provider's angle within IoT healthcare field. This interview offered vital views regarding required technology as well as good grasp for the future business ecosystem and its actors.

Quality and Development Manager of Private elderly care provider B

Another interview with a private sector actor was conducted on 3rd of May 2016 on the company's premises. The interviewee was the Quality and Development Manager of Private elderly care provider B, who has a long experience within elderly care. The main target for this interview was to get verification from the company's side that the conclusions made so far were actual and valid. In any case, the interviewee shared some of the conclusions, while she disagreed on some points. Despite everything this was an important interview as it strengthened some the views and weakened the others.

Senior Advisor of a Finnish Innovation fund

The Finnish Innovation fund has just started their ISAACUS-project, which concerns how to make use of generic health data and genome data. Therefore their perspective was considered valuable and luckily it was possible to interview the innovation fund's experienced Senior Advisor who has a broad understanding of such topics as IoT, healthcare digitalization, ecosystems et cetera, and is currently consulting the head of Finnish government for those aforementioned topics. This interview was conducted on 1st of June 2016 on phone.

Junior Development Manager of a tele operator

The interview of the tele operator's Junior Development Manager was conducted on company's premises on 6th of June 2016. The aim for this interview was to gather valuable

insights from one of the forerunners in Finnish IoT-markets who is currently investing heavily in IoT and the digitalization of healthcare. This interview proved out to be fruitful as we gained lots of practical level information of their current healthcare initiatives.

Senior advisor and Advisor of a Kuopio based Innovation company

The last interview was conducted on phone 30th of June 2016 with a Kuopio based Innovation company's Senior advisor and advisor, specialized in the healthcare sector. This company as a target organization was recommended by the aforementioned Finnish Innovation fund's Senior Advisor. They have both very good local and global knowledge regarding advanced technological solutions within healthcare industry. The preliminary object for this interview was to broaden the insights around this theme.

4.4 Analysis of the research material

A content analysis is normally a qualitative research method, which enables to review relevant relationships between research data. It may be executed from data-oriented or theory-oriented angle. This research is based on understanding of the IoT field within elderly care business. Therefore data-oriented content analysis method may be fruitful practice to analyze the data. (Vilkka 2015, 163-164)

According to Vilkka (2015, 150-151), size of a sample is not essential in case the research method is qualitative. Instead, the quality of the sample is the driver that determines the probability to create a value adding research to its audience. Furthermore, a qualitative research can be regarded trustworthy when the research object and material interpreted are compatible and when irrelevant and random factors have not affected the formation of a theory. (Vilkka 2015, 196)

Hirsjärvi & Hurme (2014, 135) state that it is important to analyze the gathered research material already during the research interviews phase. This helps to keep fresh perspective and sprout new ideas for further research interviews. However, some findings require broader perspective and longer period of time to refine into new deductions. Ojasalo et al (2009, 123) introduce the general model of qualitative research, illustrated in figure 10, in which the research material is gathered, prepared, reduced, and then studied for finding recurring structures that, in turn, lead to new interpretation and creation of dimensions to the gathered material.

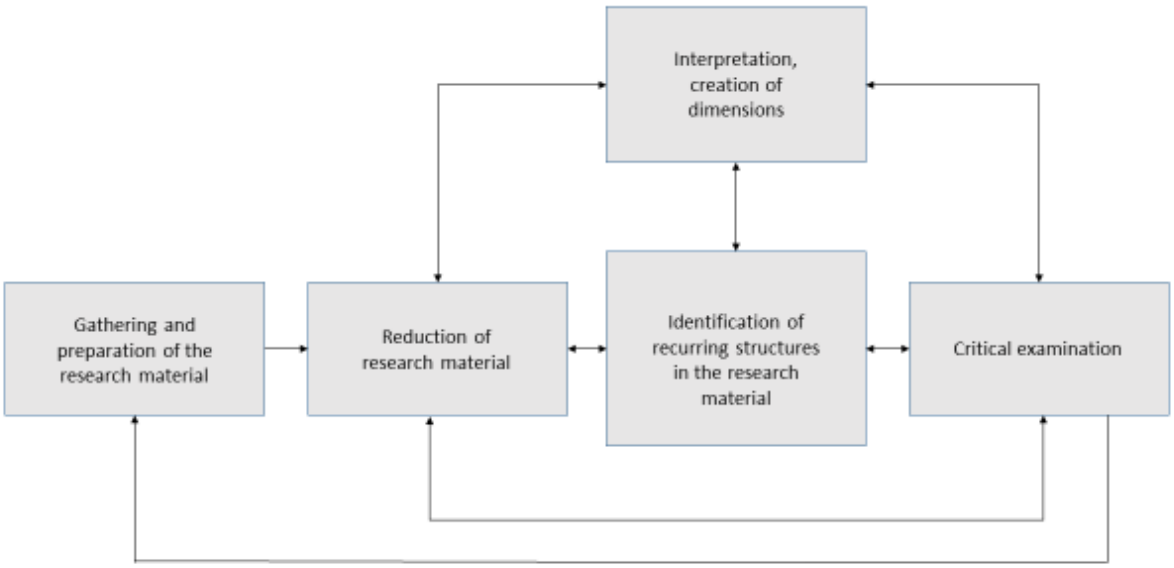

Figure 10. The general model of qualitative research (Ojasalo et al. 2009, 123)

The interviews for this research were transcribed to written form from digital recordings shortly after the interviews. These were then summarized in English with carefully selected key points and quotes from the interviews. The anonymity of the interviewees was also considered carefully and summaries of the transcribed interviews were send to each of them to be inspected before finishing the study.

Abstraction of the gathered research material was done by means of finding key points of the interviewee's views. The object was to gather the most relevant views of the interviewed professionals and then to mirror those views against each other and the research questions of this study to comprise a broad understanding of the different actors in a possible IoT ecosystem. The framework for different themes was considered already in the questionnaires that were customized to each interviewee. These themes were then developed to deductions based on earlier findings and studies.

5 The results from the research

This chapter summarizes the research interviews. The perceived business needs, and accordingly, looming IoT business opportunities within the health sector are presented based on these interviews. Further, some high-level solutions, observed from the interviews, are introduced to cover the business pains and needs. Based on these findings and learning from previous studies, the future of elderly care is sketched from the ecosystem perspective of IoT based solutions and their providers. Last, findings from this study should introduce the direction IoT related healthcare business is moving towards to, as well as present the main bottlenecks and pitfalls the industry is currently facing and may face in the future.

5.1 Summary of research results

Chapter Number:	**Research question:**	**The highlighted findings:**
Chapter 5.2	How do industry professionals perceive the current state of health care?	• Technological capabilities are on high-level • SOTE-reform represents a huge change • Educations regarding digitized solutions needs to be properly organized, avoid engineer vs. nurse conflicts • IoT based solutions still expensive and customized solutions needed • Innovative IoT applications exist • Impartial use tests for IoT technology in the public sector • Cloud services and developed sensor technology
Chapter 5.3	(i) How do the digitalization and IoT affect the health sector, and (ii) what advancements are needed to speed up the process of digitalization?	**(i)** • Predictive healthcare • Better cost-effectiveness • Prolong ability to live home • Helps to solve sustainability gap • Better access to health data • Enables new disruptive business models • Value creation and value capture with new innovations and partnerships **(ii)** • Common standards are needed

		• Renewed processes to match new technology solutions • Common privacy and data security legislation
Chapter 5.4	What kind of potential business models can be seen from a single healthcare actor point of view?	• Solution provider/data broker possibilities • Sensor technology know-how strong in Finland • Regional startups – joint ventures established to share software and hardware capabilities • New business opportunities with analyzed health/genome data
Chapter 5.5	Which kinds of ecosystems may exist in the connected healthcare sector?	• Outlined possible IoT ecosystem in the healthcare sector to describe different prospective actors within such an ecosystem • Illustration of a future public sector healthcare ecosystem in Finland • Open API's needed • Niche actors gains ground through specialized type of services • Sote-reform opens possibilities for new businesses and increases competition in domestic markets. • Added value creation for distinct ecosystem actors

Table 2. Summary of the research results

5.2 The current state of health/elderly care in Finland

This chapter replies to the research question 1 "How do industry professionals perceive the current state of health care?" by summarizing discussions with the research interviewees highlighting their most significant viewpoints to the current state of health/elderly care in Finland. Furthermore, these summaries shed light to the experience and the underlying attitudes of the interviewees as regards digitalization of healthcare. A subject deepening

SWOT analysis of the current state of health/elderly care, as perceived by the interviewed professionals, is presented in the appendix 2.

5.2.1 Insights from a Helsinki based public elderly center

Present state in the Helsinki based public elderly center

This elderly center is a subsidiary for the city of Helsinki that provides its customers with long and short term accommodation services, as well as service central for elderly and unemployed people and rehabilitation services. Main objectives are to support customers' ability to live home both physically and mentally, and to provide quality accommodation for those who cannot cope living at home. Most of the permanent inhabitants are either demented or somewhat immobilized. Operations started in 1953 and the current capacity for inhabitants is around 460 persons. The number of staff is around 400 employees comprising of ward nurses, nurses, social instructors, therapists et cetera.

The elderly center takes pride in its innovative approach to care for elderly people and strives to be innovative center for gerontology know-how. This is also noticed in other health organizations both in Finland and abroad, and they regularly receives visits from foreign professionals', one example being the Japanese health professionals.

Technological advances in the public elderly center

Activating daily life is an operational concept model for this elderly center that aspires to give customers chance to all-encompassing good life experience within its premises by supporting everyday activities, both physical and mental. The objective is to enable everyday life so that is meaningful and full of invigorating stimulus. This is achieved through careful evaluation of each customers' individual needs and restrictions and by creating a personalized care plan for each customer.

The elderly center has tested and implemented a series of technological aides in order to achieve its goals for activating daily life concept. This includes the use of Motomed motorized exercise device that helps elderly people to maintain their physical state and to alleviate the consequences of immobilization. They have also implemented ELSI safety floor technology to some of its wards. This application has a pressure sensitive sensors that are digitally connected in order to give nurses awareness of what happens in customers' rooms. This alerts nurses when their patients are on the move and possibly in need of assistance. The IITA-project, on the other hand, provides customers with a possibility to take part in group activities through remote access. This may include exercise lessons or entertainment

activities. Sävelsirkku-project is a sound experience combining sound and music and providing pleasant stimulus for the elderly people.

This elderly center participated in innovation project between 2005 and 2010. Since then they have been willing to involve distinct piloting projects in elderly care industry. They see themselves as some sort of an innovation platform for new business initiatives. In general, it is challenging for public actors in elderly care industry to get funded. Therefore pilots and small proof-of-concepts (PoC) serve their business model better. The negative side is that after a successful pilot it takes a lot of effort to convince the policymakers about the benefits the pilot has shown. Notwithstanding in most cases the elderly center can make in-house decisions regarding pilots without involving the Helsinki city policymakers.

Management views on the need for IoT based solutions

The main challenge in this elderly care center's service delivery process is locking up the doors. The people who suffer from memory disorders are somewhat treated as prisoners in a closed ward. Therefore there could be an increasingly stronger demand towards high-tech industry solutions for the healthcare sector that utilize the potential of Internet of Things in order to solve challenges in today's operating environment. Hopefully in the near future technology may enhance the life quality of elderly people and the doors can be kept open in the elderly care center and its surroundings. They see that the solution might be some sort of a Global positioning system-based (GPS) solution, which can alarm in a case person is located outside the approved range.

The suitability of such solution needs to be brought to discussions. Elderly people might easily try to rip-off wristbands, watches et cetera. Therefore it is vital to invent such an end product that is not provoking negative emotions among the elderly. These kinds of solutions with GPS features are already in use in other Nordic countries. Furthermore, the registration of falling downs should be one of the key features in this new IoT-based solution, because falling downs among elderly people are cost-heavy incidents. Moreover, it would be ideal not just to register falling downs, but also to prevent them by analyzing different sensors beforehand and acting accordingly.

Medical services is another major challenge in their service delivery processes. Relating to this, the elderly center is now starting a remote-doctor pilot project in the spring of 2016. The idea for the pilot is to figure out if a doctor could use less time per incident by handling some of the minor events remotely. This upcoming pilot is still manual in the sense that there is no sensor technology in use. Instead, a nurse in charge shall send the information via video connection to a doctor who is guiding the nurse remotely.

> *"The resistance to change among our employees is rather small. In the beginning there was a bit more resistance but innovation project in early 21st century shaked those prejudices. Currently almost all the wards are willing to participate to pilot projects, so atmosphere is very positive towards technological development. Familiarization plays a big role by narrowing the mental barrier between employees and technology."* - The CEO of the Helsinki based public elderly center

The suggested solutions as such do not suit to service housing where elderly people live more or less as tenants. Nonetheless, common spaces enables distinct business opportunities for IoT based solutions also in the service housing model. In the future, intellectual solutions will most likely be designed and pre-built to apartments and common spaces. Common spaces could for example include measurement points, in which elderly people can measure their blood pressure et cetera and resulting data would be transferred to data-warehouse and attached with person's other medical and wellbeing data which then could be processed further.

The short-term likelihood of implementing these IoT based solutions is higher in domiciliary care than in elderly care center because the information security policies may restrict sharing the customer medical data in care center premises. However, the needs and service delivery challenges in the public and private sector are quite similar. The main difference may concern financial aspects as it can be easier for a private actor to get funding.

5.2.2 Perspective of Helsinki city Chief Medical Officer (CMO)

The CMO in health and social agency of Helsinki service area was interviewed, because she has previously handled the same role in the aforementioned public elderly care center, and hence has valuable views of elderly care and how technology can help to optimize the costs and to preserve the quality of care with scarce resources. The CMO was also a member of project team that developed ELSI-intelligent floor system to this elderly center in the beginning of 21st century.

Sensors and particularly GPS are seen as one option to help modernize elderly care. GPS could help to track whereabouts of people suffering from memory disorder. However, data protection authorities and their policies may obstruct that development. At the moment there are various interpretations depending on the regional legislation. Unfortunately Helsinki area has been frozen to those unnecessarily cautious views. Another solution that would

increase the economical savings and quality of care, is automatized and optimized in-room placement which is at the moment especially time-consuming and mostly manual process.

Prolonging the ability to live at home

From the economic point of view it would help considerably if elderly could stay home a bit longer, in average for example half to one year longer. That would most likely fix the deficit of the nationwide social and health budgets. To be able to move to that direction healthcare organizations should start from the basics by rationalizing their daily operations. They should search virtual solutions to support reception activities, give uneducated employees a chance to work in the industry and try to integrate all the different IT-systems so that they discuss with each other.

> *"It is crucial that we get converging IT-systems to both social and health services. It is nothing else but a matter of making a decision. The fact that we are unable to make these kind of solutions, takes a lot of employees' time and effort. The drawback is that we don't dare to let the elderly to live at home, because these IT systems between social and health services don't interact with each other. When the information does not flow, we are forced to make expensive and often times unfavorable decisions for the elderly people."*
> -The CMO of the city of Helsinki.

When these basics are functioning smoothly, different organizations can easier introduce new IoT –based solutions and they will more likely get the full potential out of those solutions. In practice it could mean that there will be one common IT-system that includes applications, which improves possibilities for elderly to stay home longer instead of being institutionalized. In more detailed level those applications could include motion sensors, speech detector, blood pressure sensors and pulse monitors.

Finding the common ground for new solutions

One obstacle that slows down the technological breakthrough in healthcare is the competition of commercial entities, who concentrate excessively on watching over their business secrets and how those secrets could be realized to profitable solutions. The business cases in healthcare could be more beneficial to all parties if companies would cooperate more and share some of their business secrets in order to create greater added value for the whole value chain.

ELSI – intelligent floor system project lasted five years in the aforementioned public elderly center, and there were doubts in the middle of the project and even discussions about the cancellation of the project. Major issue during that time was that the engineers and nursing employees did not talk the same language. Luckily the executives did not interrupt the project as it is one very good example of a useful IoT solution in elderly care. There might be chances to build new sound based solution or different kind of wearables on top of it, which could increase added value in this elderly center.

Penetrating to IOT related healthcare business is not an easy task as it is so fragmented. Whereas big technology and connectivity providers prefer starting joint projects with small pilots or POCs, public officials may perceive POCs as a mere feasibility tests if they last less than half a year. Moreover, feasibility tests are not paying attention to effectiveness or usability of the solutions in a long run. Another problem might be that big organizations like hospitals or cities do not necessarily want to let their internal data to be included in the pilots, which makes it more difficult from IoT platform provider's point of view to create commercial pilot to the health sector. Hence there are separate views relating to the digitalization of healthcare, which creates requirements for fruitful dialogue between the parties.

> *"In addition to feasibility testing, we have to consider who will be using the new technology, and which kind of guidance and training does this require? Moreover, we have to plan the future guiding processes for new employees after the testing period ends. Therefore I would say that projects that last couple months are rarely useful for public elderly care centers."*
> -The CMO of the city of Helsinki.

5.2.3 Private elderly care provider A

Care provider A is one of the leading private sector providers of elderly and mental care services in Finland. They currently have several ongoing projects and pilots involving IoT based solutions in the care service business. Their company's role is often to act as a pilot platform for new technology and service innovations with different partners.

Care provider A has two main divisions of service, housing services and domiciliary care services. The former consists of intensified housing services for the elderly and mental care customers, and is the main revenue generator for care provider A. The latter consists of home services such as meal service and safety phone service.

Ensuring safety with technology

In terms of business development, care provider A has a product development process, consisting of technological components and service and/or concept development projects. Many of them are related to the development of care units and premises, and utilizing new innovations from digitalization. Rather than maintaining continuous think thanks, care provider A focuses on driving development projects with broad spectrum of company's professionals included in the development process, not forgetting the business aspect of service planning. Quality enhancing solutions have mostly to do with ensuring safety around care provider A's premises and daily routines, as viewed by the development and quality director.

Remote care and patient monitoring are among the focus areas in development of healthcare technologies. In addition to this, also virtual and training services are being developed for remote assistance and care for customers that are in danger of going into seclusion. Furthermore, digital registration and filing of information are being developed in order to precipitate and optimize everyday routines of the care staff. Also mobile applications are increasingly helping traveling nurses to document various customer related information. Advancing the technological aspects of service processes is only beneficial if the processes themselves are streamlined and optimized for current operations.

> *"As regards these new business models, an old saying comes to mind. If you have a bad process and you digitalize it, then you will have a bad digitalized process. Meaning that the whole process has to change. It has to be the basis for any development that you don't just develop technology for the sake of developing, but rather start with changing the whole operating model."*
> -The Development and Quality Director of care provider A.

More flexibility to care and housing solutions

The challenges of reforming Finnish Healthcare system are met with the public and private sector actors alike, albeit with different emphasis. The freedom of choice for health service provider is among the debated issues in regards to the healthcare reform. Furthermore, more flexibility is required in care and housing solutions. The advances in technological solutions can enable more cost-effective and streamlined service models to give alternative for domiciliary care and institutionalized living. On the other hand, the scarcity of human resources is also challenging the public and private sector service providers, and technology based solutions have the potential to help the personnel to cope with everyday routines without neglecting the personal needs of customers.

Care centers for the elderly and demented customers are outlining new ways of designing the housing premises and surroundings so as to not limit the movement of inhabitants more than necessary. On the other hand, vigorous security demands have to be taken into account ensuring that the customers don't get lost or hurt themselves. Outfitting customers with intelligent wearables such as wristbands could be possible solutions to help these challenges, provided that the approval is given from the customer or his/her guardians. Gathering of customers' health data with such devices can be seen as useful if analyzed properly. This would enable proactive measures to customers' health if abnormalities are detected. One application of such analyzed data could be the monitoring of manic-depressive patients activity levels. Among other useful activity to be monitored is the movement of elderly and demented people and the quality of sleep during night time. This could predict and prevent accidents resulting from falling downs.

The proper orientation of new processes and technologies for care staff is vital in order to successfully implement them. Technological solutions in themselves don't ensure quality of care, if the processes or the people involved are not perfected to accommodate them.

5.2.4 Private elderly care provider B

Care provider B is the leading Nordic provider of healthcare and nursing services. Care provider B operates all around Finland with total staff of nearly 8 000 employees in Finland. The service portfolio in Finland consists of private and municipal healthcare and dental services, occupational healthcare services, healthcare staffing services and nursing services with the emphasis on especially designed nursing homes for the elderly and demented people. Domiciliary care services are intentionally excluded from the portfolio due to the fact that municipalities in Finland evaluate the admissible cost structure too low for the private sector operators to make business profitable in this sector.

Sizing of nursing staff key element

The benefits of digitalization and IoT based health solutions are more evident in the healthcare sector and in domiciliary care compared to the elderly care centers, where the quality and promptness of care is ensured by maintaining sufficient amount of care personnel and careful designing of the elderly center premises. These kinds of solutions increase safety of care and creates cost-efficiency by reducing man hours both in the care units and in remote care. In elderly care, however, the benefits are not equally distributed due to the multifacetedness of the care sector. In the case of treating many diseases, the benefits of new technology are evident in the form of remote monitoring, online information and self-

care. Moreover, elderly people still living at home are also benefitting from these possibilities, provided that they are still cognitively sound and able to take care of themselves.

In the case of nursing homes, however, real benefits are currently harder to establish. This is mainly because of the fact that there is a strict regulation for the amount of nursing staff per customer, and this sizing of staff ensures proper quality of care, as well as constant situational awareness of the customers' condition and whereabouts.

> *"As long as these regulations for the number of staff are in place, there is no cost-effectiveness to be seen with implementing new sensor technology. Furthermore, these kinds of solutions are still too expensive for our needs, especially in the nursing homes."* -The Quality and Development Director of care provider B.

These days, elderly people are institutionalized in later stage of their life than previously, with only one to two years left in their life. At this stage of customers' life the emphasis in care is not in analyzed sensor data, but rather in interaction with care staff to ensure best possible quality of life for the last months of their life.

In contrast to the views learned from the municipal sector nursing home, sensor based monitoring of customers' precise movements, for example during night time, is not considered relevant because the design of the premises combined with sufficient number of staff is enough to ensure 24 hours monitoring of each customer. Their nursing homes are equipped with basic motion sensors helping with lightning and some aspects of movement sensoring, which is felt sufficient enough to keep the staff informed of any movements of their occupants. Compared to municipal nursing homes, the key difference in this matter seems to be better human resources per customer, and therefore the need for advanced monitoring of customers is considerably lesser.

Cost-efficiency as a demand

In the end, the question of sensor based technology and its benefit for elderly care boils down to the cost-efficiency of implementing them to daily operations. Private Service provider has to maintain competitiveness and any additional costs, without possibility to decrease the amount of nursing staff, are dealt with caution. If unit costs for these technological solutions decrease, as well as the regulated amount of nursing staff per customer, then the interest towards sensor capabilities is bound to increase. In this case, the emphasis is on the smart

design of the nursing homes and their premises, in which functionality is improved with every new building project to ensure safe and effective daily operations.

As for the long-term benefits of analyzing anonym health data in a national economy level, some potential is recognized in the future, provided that the technology becomes less expensive or is proven to enable cost cuts in staffing requirements without the danger of losing quality and safety in the process. Mere preventing of a few falling downs yearly with the help of anticipatory analytics is not in itself enough to justify expensive investments at this moment.

> *"I see more opportunities than challenges in the near future, because regardless of the SOTE reform the individual's freedom to choose increases. This offers private service providers more possibilities because the service is in any case more refined and versatile than anything that the municipalities can offer."* -The Quality and Development Director of care provider B.

5.2.5 Equipment provider views

Current industry views and SOTE -reform

The interviewed equipment provider, a small Finnish start-up, offers wireless intelligent wristbands to customers such as elderly care centers and hospitals. The company operates in Finland and in Europe and it has a total of 20 employees, from which half work in sales or marketing roles. The company's main customer segment is elderly care centers while rising segments are hospitals and domiciliary care. The company envisions that domiciliary care segment will grow as there likely will not be more elderly care centers in Finland. Notwithstanding current elderly care centers that will be modernized. There is a huge demand towards a standard global communication interface in elderly care industry. The global standard would enable new actors, such as startups, to gain market share with lower cost base. Such standard may also ease the cooperation between organizations within the industry as distinct players would share the common interface.

The equipment provider does not have any direct competitors, instead they compete against the enterprises that offer more or less old-fashioned call-button solutions. They envision that missing the direct competitors can be one obstacle for reaching even higher growth figures. In a competitive playground it may be easier to lift the visibility to a next level which would contribute to their brand.

In the near future SOTE-reform will change the whole elderly care industry in Finland, but at the moment the field is divided into public and private actors. Municipalities organize elderly care activity and private organizations offer their services to both private persons and to municipalities. There are also smaller domiciliary care organizations that do not necessarily want to have their own servers or infra in place. The equipment provider can offer them cloud based solutions as soon as they get their cloud offerings in the market. As regards legal obstacles, they have not faced that much resistance with legal issues. They instruct their customers not to fill social security numbers to the system as by adding that information they would be obliged to secure the data more thoroughly.

IoT based solution: the intelligent wristband

The intelligent wristband measures person's activity and distributes data to access points that are connected to a server by Ethernet network cable. The wristband adapts itself to person's conditions within first two weeks after individual starts to wear it. The adaptation process takes place in the server, which executes curve analysis that will act as a baseline level for further comparison. One server can easily handle 1000 end-customers, which enables effective remote monitoring and eases spotting single problems. Nursing employees are primarily interested in the data from latest two weeks of use. By measuring activity with wristband, the likelihood to state if the customer is awake or asleep, is 80 %. Another important feature is the possibility to prevent downfalls. This can be accomplished by comparing individual's standard night curve to current data. If the current level rises above the standard level, it indicates that the person has stood up and nursing employee should go and check the status of that particular customer. Therefore it can be noticed that significant results can be achieved by measuring activity or quality of sleep.

Currently the wristband delivers one-sided data from wristband to server but in the future it is highly likely that multi-sided data transfer is practicable. In other words, server can deliver data or statistical models back to wristband. One possible scenario is that mobile phones could function as an access point but the battery life cycle between charges is way too short at the moment. Already now it is possible to monitor the movement of an end-customer both outdoors and indoors and hence track the time elderly person spends outdoors. The coverage within the equipment provider's access points is between 60 and 100 meters outdoors and between 15 and 20 meters indoors. Even more accurate GPS-tracking solutions are still too expensive for actors in elderly care industry according to technical director of the equipment provider.

Again, elderly care solutions often focus on long operating time between each charging period. The equipment provider can offer extremely low electricity consumption, as their

wristband is charge-free up to 3-4 months. Their solution has also high utilization rate at 94 %, while old call button solutions can leverage utilization rates around 50 %. Preceding figures and examples explain well how modern IoT based solutions can over perform current devices and simultaneously produce yield, as well as increase life quality within the society.

The equipment provider's research and development department design the hardware by themselves and software development is outsourced to a partner. Both embedded software and mobile software development are outsourced to dedicated persons instead of executing competitive bidding process on each occasion. The company has partnered with some large IT service providers offering their solution as an integrated part of a total solution. Outside Finland integrating with other systems is even more vital in order to realistically gain market segment. Telecom operators have so far been interested in selling mobile phone subscriptions to the equipment provider. The operators have also indicated some interest to invent new business models in place of old land lines.

Eventually the main feature of the equipment provider's intelligent wristband solution is their capability to produce predictive analytics. To give an example, if a person has not slept well, the tending nurse receives the information and he or she can act accordingly and perhaps pay more attention to that particular person in the following days. In the future that type of sensor data can be used more widely by providing extensive forecasts and certain statistical models and patterns from senior citizens to elderly care organizations and their employees.

The equipment provider can already today forecast how the condition of elderly person progresses by combining generic historical activity data with personal patient record. Possible pitfalls may include the lack of generic historical data and system integration issues. Therefore the common standard is essential within the elderly care business. Fortunately elderly care organizations currently require that a new system be able to communicate and function together with the old IT-architecture when they send their request for proposals to suppliers.

Success story and latest features

Mere replacing of old devices with new IoT-based solutions does not produce fruitful outcome. Instead it is essential to modernize the whole business model to better align with new IoT solutions. For example, using their intelligent wristband solely as a call button does not produce any added value, but rather more expenses.

> *"A city of Finland has implemented totally new business model in their central hospital. Customer receives intelligent wristband immediately when checking-*

> *in to hospital. After operation they will be mobilized as soon as possible. Nursing employees then monitor the changes of patient's condition remotely by receiving activity information from wristband to their on-premises servers. As a result the city can save substantial amount of public money and simultaneously serve more citizens on-time."* -The technical director of the equipment provider.

The equipment provider has recently launched a mobile application that can be implemented together with Enterprise Resource Planning-system (ERP). It contains predominantly the same features than a full server version. Some domiciliary care organizations have utilized this mobile app. Nurses receive detailed information from end-customers to their mobile device which may help them to optimize their daily route better. In case of alarm they receive push-technique messages from end-customer's home system. The mobile app is created for both nurses and relatives. Currently they share the same view with obvious user name based restriction that nurse sees all her/his end-customers and user right for relatives is limited to one person. In the future the message for non-professional users will be simpler, as they don't benefit from curve analysis et cetera, and it may rather evoke unnecessary insecurity.

Proof-of-concept and unique education process

The equipment provider implements proof of concepts (PoC) to show the benefits of their solution. However they precisely value and compare which PoC's could add value to their business. PoC's can't be executed without certain costs so therefore it is not wise to participate to all of them. Some organizations also want to proof everything and they very rarely actually utilize anything.

> *"We have hired healthcare professionals, who have previously used Vivago's devices, to manage educating the customers. The engineers in trainer role don't produce almost any added value to customer because they concentrate excessively on technical details. This has been a very valuable decision as the healthcare professionals can concentrate on educating how the device can be used in everyday life leaving technical aspects to the background to decrease stress level of employees and to save time and costs. Besides the instructor can prefer certain features over another depending on end-customer type."* -The Technical Director of the equipment provider.

The future industry insights and importance of digitalization

In the future there might be some sort of service operator that collects the health and wellness data and processes it further to third party actors who then innovate purpose-built business model around the data. Hence, the common pricing metric in the future within elderly care business will probably be monthly based service fee. Companies are driving the industry towards the service fee model because it appears to be a budget wise choice from customer's point of view. In addition to this, maintenance service concepts will increase their popularity within the industry.

The equipment provider does not yet market itself as an IoT enterprise as it rarely negotiates with the customer's IT-department. The features and capabilities of devices plays a bigger role in today's markets. This is partly because the device currently functions as a tool for elderly person. Thus it will be even more important to help the nurses with these IoT solutions as there will be shortage of nurses within ten to fifteen years timeframe.

The current development, in which large established enterprises acquire smaller actors, will likely continue in the near future. Generally, there can be mergers or acquisitions in the elderly care industry. More newcomers such as startups may attempt to penetrate the markets as common standards and open interfaces will ease their possibilities to gain market position. Sometimes large incumbent enterprises may try to produce the service with minimum cost level which leads to the fact that some bulk versions can beat the more capable devices in tender. Anyhow, it is interesting to see if the IoT as a concept will help the digitalization to take more than just baby steps in elderly care business. At the moment technological solutions are more concentrated on healthcare business instead of elderly care.

> *"Something needs to be done in order to treat the senior citizens respectively. Currently 16 % of population in Finland is over 65 years old and by the end of 2020 decade the percentage is forecasted to be as high as 26 %. Therefor it is apparent that without technical tools and solutions nursing employees cannot cope with the upcoming situation. Naturally that is a huge driving force for IoT and sensor data solutions."* -The technical director of the equipment provider.

5.2.6 Platform/infra provider views

Often the old structures within organizations act as a barriers which prevent digitalization to break through properly. No one wants to resign from their current position so fear often leads to resistance. Many companies are searching a new type of ecosystem that is based on customer cases. It is not relevant to create a stable and ready IoT portfolio and present it to

the customer. In this new ecosystem the process starts from a certain business pain which then realizes to customer case. Consequently, different partners like startups, operators and machine suppliers are able to join that consortium. Ideally the starting point would be a small PoC which immediately delivers some results to customer. From there on, it is easier to scale up if the first PoC is at least some kind of a success story.

Partnering with startups?

By involving partners bigger companies are able to share risks but there are not many startups who are able to do so as they may lack resources. Startups should be able to establish themselves to the markets so well that they actually have something to offer in order to bring enough added value to a consortium. In comparison, big companies can offer them a chance to scale up their businesses to global markets. In the future some of those big companies and startups might merge meaning that many options for cooperation exist.

Many technology companies have been somewhat reluctant to penetrate to the health sector when it comes to IoT because the field is so fragmented in Finland and the amount of players is enormous. One example of overall solution would be creating an IoT platform to some container port and then convert that same platform to healthcare by changing only the last part of the interface. Presently many startups are negotiating directly with healthcare organizations on behalf of bigger players. Because the IoT is also heavily a consulting business, there might be room for a broker that operates as an intermediate between suppliers and customers. In other words, broker consults the customer, which components they should choose in order to maximize the benefits from the large variety of business solutions.

> *"Often these startups approach same needs from different angles, and if I, as a some kind of business angel, could choose, I wouldn't invest solely on one ompany. Instead I would invest on multiple companies that would hence be more attractive as a unity. -- By combining know-how and talents we could find more business opportunities."*
> -an Innovation Advisor from a telecom vendor.

As an example in healthcare, there could be a startup that tries to create a voice recognition system that helps nursing homes, hospitals et cetera to detect different types of movement based on sounds. A possible business case could thus be a company that introduces an IoT platform with easy-to-access interfaces for added sensors or devices. Next this platform provider handles the connectivity and operates the whole network, which is their main business.

Generic platforms and small pilots

There is a need to find a neutral counterpart in network security comparing to United States based giants like Google, Amazon and Microsoft. One reason for that is to guarantee that the customer data is not collected for their own purposes, as for example Google does. One big difference between the health and telecommunication sector is that in healthcare there are no standards and the telecommunication sector is based on standards. It is more difficult to create profitable business solutions without standards as the business does not scale fast enough. The answer to fragmented IoT industry is to build as generic platforms as possible and to start from small pilots or PoC's, which already brings added value to customers. One of the key points is to set a correct price level for future business solutions and even more important is to concentrate on the cost of customer life-cycle. The pricing metric could be based on monthly invoiced service fees, which could include certain thresholds based on performance agreed with supplier and customer.

The emergence of new IoT business opportunities signifies that value chains are re-established meaning that old players like telecom vendors and operators might end up competing with its own customers in the IoT field. Therefore in the future there might be scenarios in which a telecom equipment provider assigns some of the potential deals to its current operator customers. In the near future the focus of core competence is bound to shift from connectivity increasingly more to the service-layer in the IoT ecosystem. As the value chain changes and new kinds of ecosystems are established, this calls for differentiation for certain business sectors or business models within IoT as the fragmented field demands specialization. Also in global scale it will benefit all consumers if the IoT field remains fragmented as there will be more innovations and more competition. Further findings from the telecom equipment provider perspective on the IoT business opportunities are presented in appendix 2.

Cost savings to enterprises is one key factor, which has been achieved so far in IoT business. There are not yet so many concrete business solutions, which create totally new businesses for customers. IoT should also enable totally new type of businesses, which are bound to increase drastically as IoT really starts to bloom in the western world.

> *"I am hoping that the competitive field (and possible IoT ecosystems) stay fragmented as, the more there is competition, the more we will have innovation and thus gains to consumers. If, instead some monopolies arise, it is bound to increase the prices of services."*
> -an Innovation Advisor from a telecom vendor.

5.2.7 Teleoperator insights

The interviewed teleoperator is a public Finnish service provider, whose core competences are in telecommunications, ICT and online services. The company has somewhat adapted a pioneer's role in Finland regarding IoT along with few other organizations. They started their IoT B-to-B unit in 2014 from scratch, and the unit now consists of approximately 20 employees. One of their core target industries is healthcare, and primary solutions within the healthcare sector are related to remote measurement and tracking solutions. Asthma, blood pressure, weight and blood sugar are such things that can be measured remotely by intelligent devices and applications. The upcoming application will enable remote measurement of blood thinning treatment.

> *"We search duplicable IoT solutions, which are suitable for global markets. However, we haven't yet been able to gain market position outside Finland as IoT is still such a new thing for us. We are searching innovative startups and try to help such similar type of startups to connect with each other with an aim to create fruitful innovations. We utilize Lean Startup –model in productisition phase, which enables small initial investments as this iterative process gathers customer feedback as early as possible. The projects quite often start by common workshops with potential customers."*
> -Junior Development Manager of the teleoperator.

Domiciliary care as a trendsetter

Customer is paying the costs ensuing from these pilot projects, which also ensures that they are seriously interested for the subject matter. Therefore moving from pure customer discussions to the actual proof-of-concept is the most demanding and time-consuming phase. Timeframe for the technical PoC's are typically few weeks, but the whole pilot process may take anywhere from few months up to a year before the customer is convinced about the new technology. One issue is that rather often no one wants be an early adopter regarding new operational models. Other things, that may delay or prevent these new IoT initiatives, are the lack of resources and technology centered approach. Processes must be changed according to new service model and thereafter new technology can be acquired to support the new process. Also resources with adequate skills and enough free time should be appointed to procurement process already in pilot phase. Furthermore, in optimal scenario the turnover rate of personnel should be minimized in IoT projects, which can be achieved by properly engaging staff to the project.

> *"I believe that IoT will bring more added value to domiciliary care services comparing to elderly care center services. In other words, the digitalization will enable treatment at home or in generally speaking the customer's location will become irrelevant."* -Junior Development Manager of the teleoperator.

Mobile ERP's will become more common as they provide the possibility to prioritize time-critical incidents. Another possibility is that consumers will buy more home-security equipment, which then shall be integrated by IoT technology to municipality's IT-systems. Such development removes the need of buying similar type of solutions to every elderly citizen.

Tele operator's industry insights

The teleoperator envisions that the future healthcare IoT-ecosystem contains both smaller niche actors and big multinational corporations. Open API's provide easy access to all service providers who are willing to grab a small portion from these markets. The future top performers are the organizations that have deep subject matter knowledge and have potential to expand their operations globally. The public sector enables impartial usage tests for new technologies in Finland, which may help local actors to develop their services. Furthermore, the My Data –ideology is bound to gain more breeding ground in healthcare, which in practice means that customer's power towards their personal data will increase.

Revenue model will most likely based on either monthly service fee model, or performance based model depending on the scenario and ecosystem. Both models have their advantages and pitfalls. Monthly service fee type of model is the easiest to implement, but some services, due to their nature, may demand performance based pricing model.

This teleoperator believes that community spirit will increase. This is affected by the fact that the condition of elderly person may change rapidly, which reduces the rationality of investing large sums to newest treatment or measurement devices. With that in mind, a recycling of such devices play also a vital role, thus distinct type of rental and lending services may gain market shares within healthcare industry. It is also important to teach how to use these devices, which may provide business opportunities for consulting services.

Privacy issues and digitalization timeframe

European Union (EU) is planning a new law regarding privacy and my data security, which shall unify today's distinct laws within EU. Such progress will remove some barriers for global

market entries because the need to learn each country's own legislation partly disappears. This new law may also improve data security in IoT business, which can speed up the digitalization within healthcare industry. There has also been discussions of having some sort of certificates, which helps an organization to prove it is reliable and data protection is realized.

With the help of advanced analytics it is possible to get the doctors to trust measurement sensors and data figures within ten years timeframe. Robotics and virtual reality services will also gain market position within the same timeframe. City of Vantaa already has a pilot project in robotics, in which the aimed full implementation should occur in 2020. Remote measurement and self-treatment solutions will increase mostly within those customers, who demand continuous healthcare services. It has been said that 10 % of people in Finland spends 80 % of all healthcare services.

5.2.8 Finnish Innovation fund views

This Finnish innovation fund is operating directly under the Finnish Parliament, and its decision-making processes are regulated by parliamentary procedures. Their administration consists of Supervisory Board, Board and President. In the area of healthcare and welfare funding, they are one of the drivers in an aim to move to a single-channel funding for social welfare and healthcare services, where equal access to care is granted. As Finnish citizens will have the freedom to choose their health service provider, the private and public sector are forced to work together. In this design money follows the customer. (Finnish innovation fund 2016) How this works out in practice remains to be seen and is yet to stand the test of time. The Innovation fund establishes that the problems associated with Finnish healthcare system consists of inequality and the lack of coordination, incentives and transparency as regards care quality and costs. The existing system emphasizes on the treatment of illnesses instead of supporting wellness and the prevention of diseases.

The encompassing reform of social welfare and healthcare services in Finland is already underway. The government's objective is that in the future 15 regions will be given the responsibility to organize social welfare and healthcare services. Moreover, a working group has been appointed by the Ministry of Social Affairs and Health to study alternatives for retiring multi-channel funding of social welfare and healthcare. (Finnish innovation fund 2016)

The innovation fund's role in the healthcare sector

Finnish society is currently struggling to overcome a sustainability gap, and the demand for saving is 1,5 billion euros in the healthcare sector. The big healthcare reform in Finland

targets to bring these savings through organizational and legislative reformations, and with the benefits from digitalization and innovative technological healthcare solutions. The innovation fund is funding and overseeing several projects that aim at finding best possible solution for the healthcare reform. Rather than directly funding startups, they direct funding through different themed trusts that fund promising projects. These are typically carried out by public instances with technological innovations from either startups or established companies.

One example of such a project is the trial of automated decision supporting health system that advices people to choose between self-care and visiting a doctor. Moreover, the possibilities for enhanced domiciliary care are studied with the help of new technological aides such as remote monitoring of patient's health. Helsinki and Uusimaa hospital district (HUS) is currently conducting a project in which patient's pace maker submits real time data to cloud. This data is then analyzed with analytics software and the aim is to predict possible upcoming heart failures.

In the case of domiciliary care for the elderly people, the pace, in which new technological improvements are implemented in Finland, is found surprisingly sluggish. Japan is already making wide use of robotics in order to prolong the ability of the elderly to live home. The innovation fund believes that home diagnostics and domiciliary care with the help of IoT and new equipment are bound to increase also in Finland. Moreover, as these kinds of new innovations are currently mostly funded by private persons, the upcoming healthcare reform calls for new kind of thinking in order to streamline health services with scarce resources. This could mean integrating several independent manufacturers' equipment to form reasonable and efficient domiciliary care systems.

> *"The freedom of choice will mean that both the private and the public sector are competing to organize same services for citizens. Money will follow the consumer and this forces public actors to count the total cost of keeping people healthy. The idea is on the other hand to decrease expenditure on health services, but on the other hand to encourage the development of health related technology as a national competitive advantage. It is probable that the private sector as well as insurance companies will be the ones in the frontline, because they have the economic incentives to do so. However, the public sector will have to follow suit, if they wish to keep competing for the same service tasks. This means implementing new operating models, but also introducing new technological aides since the amount of helping hands is not going to be enough."* -a Senior Advisor from the innovation fund.

There are already high-grade health technology companies in Finland that are exporting their innovations globally. These companies are lesser known in Finland because their markets are elsewhere. Sensor and diagnostics technology developers are well presented within the industry and now increasingly seeking new ways of networking with other actors in the business in order to form ecosystems with mutual benefits. This might also mean startups teaming up with big global players such as IBM, Pfizer or GE Healthcare in the hopes of utilizing their vast networks.

The ISAACUS project

The ISAACUS project has two focal objectives. The first one is to collect wide-ranging health data from multiple professional health instances such as University hospitals, HUS, Ministry of social affairs and health (STM) and National Institute for health and welfare (THL), bio banks and gene banks. Moreover, the idea is to gather citizens' own health data, combine with other sources of data and also to offer it to other uses with the consent of the individuals. HUS is currently conducting a major project, in which big data is transferred into Hadoop open source data warehouse to be accessible for various forms of data analyzing. In the second phase this big data can then be used in studies or directly in healthcare applications with the help of specific algorithms.

The third phase is the extradition of the disposition of the data to third parties. This might mean studying x-ray photography in order to develop detecting algorithms or utilizing genetic information for the use of clinical medicine research. This requires defining regulatory measures for data privacy and access rights. The other main objective for ISAACUS is finding business opportunities and models from this vast amount of health data, and there are several ongoing projects, plans and trial runs for this purpose.

Cultural differences

The healthcare business is a broad field of opportunities for different sized actors. Some sectors might be dominated by big actors such as Google or Microsoft, but not all, however. Such major companies have the economies of scale with the huge amount of versatile data gathered by them directly from the consumers. It is, however, unlikely that they would dominate the whole market, but rather be focused on selected strong sections of it.

> *"As for the treatment of elderly people, we have huge cultural differences between countries and continents. Finland has traditionally shut its elderly people to institutions, and therefore is facing problems with their seclusion. Whereas in Catholic countries it is considered essential that the elderly people*

> *are included in the extended family of their children and typically live in same houses. In these cultures there is lesser needs for remote care and technological aides thus making exporting of such devices challenging for Finnish startups. Japan, on the other hand, is more open to these kind of innovations because their elderly people, whilst living with their offspring, often spend their days alone while their children are doing long working days. All told, I believe that the biggest developments in the health technology business come from small companies and their innovations. Furthermore, most of these innovations require first-hand contact to potential customers and development work done close to them. This might limit the eagerness of bigger companies to expand their offering to all fields of the business."*
> -a Senior Advisor from the innovation fund.

Changes toward the 2020's

Most of the current technological developments are currently implemented through PoC's and prototypes. Whereas public actors are willing to share their experiences and findings from pilots, the private sector actors are less willing to do so, because they want to guard their competitive edge. Finnish government has a strong intent to encourage more pilots in health technology, and legislative changes are being made to ensure that certain public procurements are done through innovation projects that can sprout new business ideas. Legislation is also renewed in order to facilitate more flexible healthcare service and exchange of patient data. Data protection and privacy issues are being streamlined to give citizens wider possibility to grant authorization to relatives. This helps people to tend everyday routines on behalf of their demented or immobilized relatives. People should also be able to check what kind of personal information is exchanged and by which authorities.

The planned healthcare reform in Finland will happen gradually, with clear changes coming into effect in the early years of 2020's. Most of the changes required have to do with streamlining legislation and processes, as well as defining cost structures and municipal care units for both the basic healthcare and also for specialized care. Technological innovations can help many of these new processes and help to cope with scarce resources, but it can't in itself solve national deficit problems in the healthcare sector.

5.2.9 Insights from a Kuopio based Innovation company

The interviewed Kuopio based Innovation company is a business developer that strives to establish new opportunities for innovative companies by combining ideas, experts and new ways of thinking. They act as a supporter, helper and mentor of businesses. Furthermore,

they help their customers to develop business ideas and activities by preparing and coordinating business-oriented development projects and providing funding advice and project preparation services. Their objective is to promote the creation and growth of business and enhance the vitality of the Kuopio region. This is done by developing regional collaboration and by promoting networking between companies, key research groups and the public sector.

Innovative health technology in Kuopio region

There are a lot of health technology specialized companies in the greater Kuopio region. They develop sensor and measuring instruments, and precipitating their product development and marketing processes in one of the company's tasks. There is also a project that strives to counsel companies to better utilize digitalization in their business. Moreover, special weekend gaming jams are organized to experiment different opportunities with sensors and health related gamification applications. These jams are attended by various professionals from the health sector; tech startup people, city officials and healthcare professionals gather to exchange ideas and experience and to brainstorm gamification methods in healthcare applications. It is widely perceived that sensor based measuring of health data is going to become more and more common in domiciliary care.

This innovation company is a development company, mainly owned by the city of Kuopio. They are in close cooperation with the city and with KYS university hospital of Kuopio. The object is to unify public healthcare with solutions from corporate world and tech startups. By doing this they aim at promoting new businesses and their ideas to both the private and public sector actors. Similar development companies can be found in some other major cities in Finland, such as Tampere, Turku and Oulu. These actors get together regularly and do cooperation in promoting Finnish startups to different parts of Finland with the help of their social networks and expertise.

Development projects are mainly derived from the needs and desires of customer companies. Some projects are initiated by the Innovation company as 'new openings', derived from perceived social needs in Finland. Games for health initiative started in 2014 aims at uniting gamification methods with healthcare and rehabilitation of patients. Initial rejections by health professionals have slowly started to change into interest with small experiments and demonstrations. It is also important to maintain constant dialogue with government officials and to promote projects that are considered beneficial for the SOTE reform. The Innovation company also coordinates with EU officials in order to advance common objectives such as the welfare and safe living environment for elderly people.

Sensor technology in use

IoT based solutions are well presented in the projects and openings conducted by this Innovation company. Mega-elektroniikka, for one, has for thirty years developed ENG sensors - electromagnetic system indicating brawn - that can transmit useful health information to be remote sensored and analyzed. EEG headband, on the other hand, can detect vascular anomalies in the brain and help to prevent permanent brain damage with fast response.

> *"Regarding EKG-sensors, there is this Megakoto company that has developed Kardio service in which EKG sensor emits data via Bluetooth to a smartphone and onward to a remote server to be analyzed by a doctor, who can detect if the monitored patient has arrhythmia. Also blood pressure and blood sugar levels can be remotely sensored and analyzed with specific online accessible gauges. Then there is this INR-gauges that are used to measure blood thinners in vascular system. These are tested by KYS in hopes of reducing hospital visits by patients. One of our startup clients is developing software that could combine this various sensor data to cloud to enable health specialists to give statements, write subscriptions and to give care instructions directly to the patients. These kind of services demand certifications and approvals from Valvira."* -a Senior Advisor from the Kuopio based Innovation company.

As for the ISAACUS project, this Innovation company is in cooperation with Sitra and finding ways to utilize massive amounts of health data. Automatic decision support system is being tested in the city of Hämeenlinna by Duodecim. This kind of system has the potential of reducing doctor visits with some of the diagnostics done automatically by the system. Furthermore, insurance companies are also in the forefront to utilize such unified data if given chance. They might want to renew health insurance products and premiums to better consider customer's life style and hereditary diseases.

Adjusting to elderly people's changing needs

The needs of the elderly people change often rapidly and are challenging to predict. In case of demented people, the decline in cognitive functions progresses individually and concurrently the special needs of the patient has to be addressed with right kind of aides. Sensor technology and intelligent wristbands help to monitor the movement of the demented people and can send useful information about their condition to health professionals. The challenge is to gather and analyze all this information for the purpose of efficient treatment decision making. Tubelco project in Kuopio addresses these challenges by assembling domiciliary care service needs into a single safety service, a sort of safety service central that

gathers different sensor health data for the purpose of evaluating individual need and urgency for treatment. The object is to have a capability to send right kind of help to right place, and just in time.

> *"The city of Kuopio is currently inviting tenders to form a network of care services that will be controlled and coordinated by the city by demand from its inhabitants. It includes both public and private service providers ranging from domiciliary care and cleaning services to help done by voluntary organizations. Furthermore, relatives of the elderly people are demanded to take bigger role in the care process, either by buying the services or by helping themselves. The resources of the city is not going to be enough in the future."*
> -a Senior Advisor from a Kuopio based Innovation company.

Reshaping procedures and operating models is the key factor in making a successful healthcare reform. Technical aides are already there to make things more efficient but the healthcare workers have to commit to using them as part of their everyday routines. Often the process of learning is the biggest obstacle in implementing new procedures.

Sensor technology in use in Kuopio

Mega-koto is an example of a small healthcare ecosystem with their EKG-Kardio service. In this service sensor technology is from one company and Mega-Koto uses it to their software which is sold to the customer as a service including EKG statements from health professionals. Correspondingly bigger ecosystems include several equipment providers, several health specialists and so on. Remote care services are nowadays compensated by KELA, which is important factor in keeping these new projects afloat. Implementing new technologies and procedures and successful market penetration don't come cheap and it takes time regardless of the potential of the innovation.

The healthcare reform in Finland is bound to attract more service providers to the business. Standardization in sensor devices is already well in progress and the data transfer infrastructure is adequate in Finland. The challenge is to implement unified interface for all health data to be utilized by all potential service providers. The healthcare reform should solidify this object with the help of government operated data interfaces Kanta and Omakanta. With these developments and improvements, the bigger players such as Nokia or Elisa are more and more interested to take their share of the emerging health technology markets. Particularly when they have also European markets in mind.

5.3 Digitalization's impact on healthcare

This chapter examines the second research question, "(i) How the digitalization and IoT affect the health sector, and (ii) what advancements are needed to speed up the process of digitalization?". The selected themes are addressed by highlighting nationally significant healthcare topics based on the interviews.

5.3.1 Institutionalized care

This study aims to deepen the understanding of the challenges of Finnish elderly care and, moreover, to outline the kind of business pains that could be accommodated with the help of IoT based technological solutions. There indeed is a clear demand for new technological solutions to help the employees of elderly care center to cope with scarce resources. For this study, a wider perspective on this theme was obtained by interviewing the private sector care providers in addition to public elderly care professionals. These private sector interviews indicated that there are both similarities and differences in the viewpoints towards new technology in institutionalized care.

Supporting customers' everyday activities, both physical and mental, demands evaluation of individual needs, as well as a personalized care plan for each customer. Both the public and private service providers strive to achieve these objectives. The most important issue in 2015 project study, according to the interviews conducted in the public elderly care center, turned out to be safe area movement around the elderly care center premises. However, the resources are not equally sized among nursing homes and, thus different challenges are met in everyday operations by each operator. The number of care staff is heavily regulated in Finland and affects the possibilities to develop new operating models. The aforementioned public service provider, as it turned out, would benefit clearly from new sensor technology to enable free, yet monitored movement for its end-customers around the care center premises. The buildings are old and somewhat challenging to enable free movement since the design of the premises is outdated and inefficient.

Custom designed facilities

The private sector service providers, on the other hand, benefit from modern house designs that are better suited for modern needs of the care provider. Consequently the need for sensor based monitoring technology is less required in modern care centers. Particularly as the minimum demanded number of staff remains regardless of new technology and no substantive cost savings can thus be seen by installing new technical aides.

Nonetheless, careful design and installment of sensor technology is bound to become more common also in the future building projects of public care centers and elderly homes. New

kind of common spaces could, for example, include measurement points for measuring blood pressure or other functions with the health data collected and stored for the use of doctors and other health professionals.

Both the public and private sector elderly homes are essentially open for testing new technological aides, as long as they don't consume excessively of their time or resources or produce additional costs to daily operations. Some of the technology is given short test periods and might be implemented to some locations of the service provider. These can be, for example, motorized exercise devices, pressure sensitive sensors for monitoring movement, or devices such as tablet computers to enable remote access to group activities.

Different priorities

When it comes to getting funding for new projects, the public sector actors suffer from rigid policies and sluggish decision making. In light of this, pilots and small proof-of-concepts serve their operations better than big projects. On the downside, even with a successful pilot it still takes a lot of effort to convince the policymakers about the benefits of the pilot.

In many areas of health technology, domiciliary care will likely act as a forerunner in implementing new innovations into practical use. This is due to the legal and privacy restrictions that affect institutionalized care more than domiciliary care. In itself, the needs and service delivery challenges in the public and private sector are quite similar. It is rather the funding aspect that may be the biggest difference as regards implementing new innovations.

From a national economy standpoint, the objective is to prolong the elderly people's possibility to live home. This is also why domiciliary care stands to gain most from IoT based solutions. As for the future improvements of institutionalized care, most enhancement is to be done with rationalizing and streamlining their daily operations with the help of modern IT systems. As stated before, there is no use in digitalizing bad processes. However, when the basics are functioning properly, it is easier and more worthwhile to implement new applications to the daily routines.

5.3.2 Predictive healthcare

Predictive healthcare, in the best possible scenario, can start a new digitalized era in elderly care industry, which leads to significant savings and thus enables to bear the costs caused by ever-aging society. The preliminary idea in predictive healthcare is to exploit anonymous and/or generic patient data in order to predict incidents and sicknesses prior to an actual

realization of such accident or illness. Other option is to make use of genome data in such predictive manner that enables pre-treatment measures with an object of cost-savings.

The private sector will most likely act as a forerunner, even though SOTE-reform may enforce the public sector nursing actors to act similarly. The aforementioned may become reality if the freedom of choice included in the SOTE-reform compels both the private and public sector to compete on an equal footing. Such competition may enrich the whole healthcare industry by expediting the utilization of new innovations. On this basis it can be concluded, that most of the respondents experience SOTE-reform as a positive re-organization of Finnish health services.

The predictive healthcare, itself, can turn the whole earning logic upside down. Likely in the future, end-customers will pay money based on their state of health instead of losing money each time they become sick. The monthly based consulting fee, specified earlier, may be the best pick for a revenue model when predictive healthcare breaks through properly.

5.3.3 Insurance company aspect

The research interviews of this study indicated that the role of insurance companies is substantive in shaping the Finnish health industry. They have a clear incentive to be in the forefront of digitalizing the health industry for a number of reasons. Firstly the compensations paid by insurance companies stand to decrease significantly if accidents or illnesses can be better predicted with intelligent health applications. Secondly, insurance companies can better adjust their premiums to correspond with the actual health risks of their individual customers. They can also attract health conscious customers with new kind of health insurance products that incite regular self-made health monitoring by promising cost reductions to the insurance premiums.

For insurance companies the most expensive cases are those injuries that lead to lifelong medical expenses and compensations. The possibility to reduce these cases is a strong incentive for any insurance company to invest in innovative technology with predictive capabilities. It is hence easy to foresee, that insurance companies are increasingly eager to team up with innovative technology providers in order to develop new kinds of insurance products and new ways of monitoring their customers' health and lifestyles.

5.3.4 Technological insights

From a pure technological point of view, an integration process isn't that difficult. The challenges arise when an organization tries to adapt new processes simultaneously with new technology. In any case, as stated before, technology itself does not build new effective processes. Instead they need to be reformed separately by taking into account all the prerequisites placed by technology.

In addition, standardization and open application programming interfaces are important enablers for a broader ecosystem, as they offer smaller niche players, such as startups, an easier opportunity to gain ground in a certain ecosystem. Common standards are warmly welcomed by distinct actors, like teleoperator, platform provider and equipment provider, as those standards ease their chances of building scalable and replicable services and applications.

Virtual hospitals and robotics were also brought up by some interviewees. Virtual hospital does not demand any physical location, but instead a doctor may treat domiciliary care patient remotely with the help of new technology. Robotics is an interesting topic, which gradually increases its popularity within the health sector actors. So far Japan has been a global forerunner regarding robotics in healthcare business but step by step also Finland starts to show its interests towards this field of technology. Nonetheless, the expected expansion of virtual hospitals and/or robotics is not about to happen in short order because they both demand heavy adjustments to current processes.

5.3.5 Possible barriers

Possible barriers to the emerging IoT based ecosystem include outdated and rigid legislation, and the current diversity of global standards. This is understandable since many of the new service innovations demand versatile usability of health data that has traditionally been disposable only for restricted group of healthcare actors. Governments around the world have started to reshape legislation, but it is not a simple task as so many aspects have to be considered starting from the privacy issues regarding the use of health data. Moreover, the apparent need for globally unified standards is generally recognized, but the process of standardization takes time as many of the new innovations and solutions are dwelling on virgin territory.

The implementation of IoT-based technology may also face barriers from general attitude. The challenges of out of learning are well-known for any organization, and a demand for controlled change processes is apparent. Moreover, the doctors have to trust IoT-based

technology in order to favor it over traditional healthcare solutions. Furthermore, for private and public actors alike, there is also financial risk involved concerning initial investments to new technological solutions. These actors might find new technology too expensive and not enough tested for purpose and functionality. The cooperative developing of standards and solutions also suffers from private companies' reluctance to share their business secrets with other actors. Besides aforementioned, a weak development of battery technology may prevent or slow down the utilizations of these IoT based solutions especially in the health sector.

5.4 Possible IoT related healthcare business models

This chapter presents the third research question of this study: "What kind of potential business models can be seen from a single healthcare actor point of view?" Examples of IoT related healthcare business models are pinpointed in this chapter. Furthermore, a solution provider business model will be highlighted with the help of Business Model Canvas tool.

5.4.1 Suitable IoT business models in connected healthcare

The healthcare industry has one of the biggest potentials for IoT based solutions and digitized business models. It provides fertile ground for a wide variety of actors to introduce new technologies and business models as part of new forming ecosystems. This field of opportunities is still very much a virgin territory as established multi-national companies seek to team-up with agile startups with fresh ideas.

Solution provider model

According to Frankenberger and Csik's (2014, 300) business models, one potential model for a healthcare sector IoT actor would be to become a solution provider offering an encompassing coverage of products and services in a particular domain and in a single package. This would mean customized service packages, supporting consulting services, as well as the physical product elements and their maintenance included in the service agreement. Rather often these solutions include both physical and immaterial components, such as software, hardware, device, wireless communications et cetera. These components, even though development originally outsourced to distinct actors, often will be bundled to a single package, containing all the embedded components.

This type of solution provider model would enable the customers and end users, in this case the elderly homes and elderly persons to concentrate on their core operations, businesses and daily routines by outsourcing certain areas of expertise. A solution provider may increase its

revenue by inventing new ways to extend its range of services and by scaling them to match different sized and types of companies and their various business pains. In other words solution provider should offer a careless, well-functioning and value-adding comprehensive solution to its customers. This study concentrates on solution provider model more thoroughly in the next chapter.

Open business model

Another possible business model for a health sector actor could be through open business by leveraging collaborative value creation (Frankenberger and Csik's 2014, 230). The adoption of this particular model can be seen as a fundamental paradigm shift in a company's business logic as it refers to partnering with outside partners with usually closed value creation process such as research and development. In an increasingly connected world with converging industries, this open business model aims at future growth and competitive edge through cooperation among distinct actors.

In the healthcare sector this could mean developing an entire ecosystem to create unique value to the customers that none of the participating actors could provide independently. The success of any such ecosystem relies on the sufficient revenue and evident benefit from the collaboration created for each actors.

Osterwalder et al. (2010, 108-119) defines that in open business models an organization systematically shares ideas and collaborates with distinct actors in order to create and capture value. By adapting these new kinds of Research and Development (R&D) practices it can possible to reach significantly better service level and customer feedback. Therefore in addition to aforementioned, sharing of information is crucial in such open collaboration model.

Leveraging customer data and multi-sided platform business model

Leveraging Customer Data (Frankenberger and Csik's 2014, 201) can also be seen as an integral way of creating revenue in a healthcare ecosystem. As customer behavior and transactions leave constant digital footprints that can be analyzed from various perspectives, this information created can be leveraged into use when merging new kinds of revenue logics and business ideas. All sorts of predictive healthcare and elderly care business solutions need to exploit big data and thus some actor needs to be responsible for leveraging the customer data to distinct actors that plans to build new solutions with revolutionary revenue logic and new predictive business models.

In addition, a multi-sided platform business model gathers two or more distinct groups into the same ecosystem by making them dependable of each other, could bring added value to the IoT healthcare sector. Such platforms bring value to one group of customers only if the second group of customers is also present (Osterwalder et al. 2010, 76-77). There will most likely be data brokers et cetera who gather the data from sensors owned by distinct organizations and convey it further to individuals and companies who are willing to pay for certain type of data in order to exploit the data to their benefit. First group of customers could be for example elderly person's relatives willing to pay extra fee for analyzed patient data, the latter group instead could be companies which intend to innovate new service solutions to the healthcare sector. They both are dependable of each other in the aforementioned scenario, in which patient data is needed in order to create new IoT based services to markets. In addition, one group of customers in such multi-sided platform business model could be medicine companies that market their products based on analyzed data.

Long tail business model

Long tail business models focuses on selling less of more, in other words an organization has wide variety of products, each of which sells relatively infrequently (Osterwalder et al. 2010, 67). An elderly care organization could consider long tail business model as an add-on to wealthy customers.

With the help of sensors and intelligent data, different wellbeing services could be offered to end-customers and their relatives. Elderly center could have, for example, an a-la-carte list of services that arouses interest among elderly people. These types of niche offerings may fulfill the increasing willingness to monitor individual's health status. Despite of this, the best value proposition may focus to the wellness sector rather than actual healthcare or elderly care sectors.

5.4.2 Case example: Business Model Canvas – a solution provider business model

This chapter illustrates one potential IoT related healthcare business model, a solution provider model for location tracking IoT solution, by using Business Model Canvas tool. The aim is go through all the sections and most relevant points from the Canvas. This BMC has been sketched from a high-level perspective leaving detailed level information of this location tracking solution intentionally to background, as this study does not concentrate on detailed level concrete business models. Figure 12 presents this high-level hypothetic Business Model Canvas.

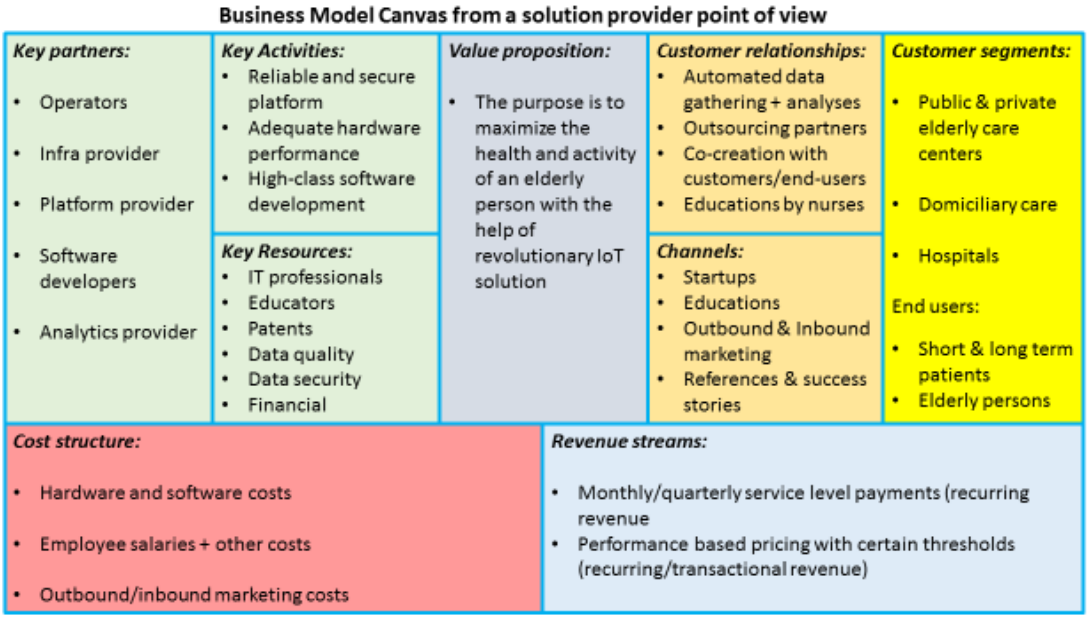

Figure 11. Business Model Canvas from a solution provider point of view

Customer segments are most likely related to elderly care centers, hospitals and domiciliary care. End users instead are logically elderly persons and short and long term patients in hospitals. The purpose of this hypothetic solution is to maximize the health and activity of elderly person with the help of revolutionary IoT solution. This sort of location tracking solution may help to improve the activity of elderly person, as it allows individuals to move more freely without supervision. Also health status can be improved for example by tracking activity and preventing downfalls.

This type of IoT solution provider business model requires different type of customer relationships in order to build profitable business. The business model may include distinct outsourcing partners, such as software or hardware developers, co-creation with customers or other stakeholders, automated data gathering and analyzing processes with 3rd party actor and after-sales education regarding the use of an actual solution. Therefore it can be noted that in most occasions a future IoT based solution provider ecosystem consists of distinct industry actors and even cross-industry types of horizontal ecosystems will likely exist. In any such ecosystem solution provider plays a key role and enables the presence of all the other actors.

In addition to customer relationships, different channels are needed depending on each business scenario. Possible channels for solution provider could be startups, distinct outbound and inbound marketing activities, references and success stories and education events. Startups may perform some parts of the solution and they could function as a customer interface towards customer. Different marketing actions are also essential, and thus it is

highly recommended to use references and success stories as a part of a marketing message towards customers.

There are various potential revenue models to choose from, but based on the interviews, most likely distinct recurring revenue type of models will outdistance traditional upfront and subscription fees. The baseline fee for revenue stream in solution provider business model is likely some sort of a monthly or quarterly service level payment. In addition to that, there may be a performance based pricing models with certain pre-determined thresholds. These two types of revenue models may be replaced by more traditional methods in some solutions, but in a likely scenario these recurring revenue models will outperform distinct transactional revenue models in IoT based healthcare solutions.

Cost structure in solution provider business model typically consists of multiple fixed and variable costs, such as hardware and software costs, other R&D costs, employee costs, as well as marketing costs. However, these can vary quite heavily depending on the actual business scenario. Software and/or hardware development may be outsourced to a third party actor, which increases those cost types but simultaneously reduces employee costs. Marketing costs on the other hand are the foundation of a success for such business model, and therefore can't be totally avoided. However, a careful planning and execution process may reduce marketing costs, in particular if the amount of inbound marketing can be kept significant.

A solution provider needs certain activities, resources and partners to utilize the business model successfully. Activities are mostly platform, hardware or software related. Naturally there are other obvious activities, such as employee and customer education, marketing activities et cetera. Key resources instead are highly connected to activities, thereby in IoT solution provider business model, the key resources are firmly connected to employee and data related subject matters, not forgetting financial aspects. Ultimately partners enable the success of a certain value proposition. Depending on the business case, the following type of key partners can exist: operators, infra providers, platform providers, software developers, and analytics capabilities providers.

IoT case example: Real Time Location System platform

Helsinki and Uusimaa hospital district (HUS) has deployed a Real Time Location System platform (RTLS) from a United States based healthcare solution provider company. The purpose of such platform initiative is to automate the management of the critical equipment of HUS, such as IV pumps, patient beds and wheelchairs, which previously were handled by manual processes. Thanks to this new platform, HUS will have unparalleled visual access to locations and resource status of more than 3 000 medical assets. (Stanley Healthcare, 2016)

This new type of IoT solution reduces significantly the cost structure of HUS as well as the amount of time caregivers spend to tracking these assets. In addition this RTLS solution may streamline the preventive maintenance process regarding medical assets that HUS needs to take care of. The solution utilizes hospital's current Wi-Fi infrastructure and thus is able to proactively monitor and manage the status of medical assets across the hospital premises. Through a reporting layer HUS receives an unprecedented operational insights for making necessary activities based on trend analysis derived from historical data. (Stanley Healthcare, 2016)

> *"As the largest of the 20 hospital districts in Finland, HUS recognizes the importance of staying on the forefront of technology to reduce healthcare costs and provide high-quality patient care."* (Stanley Healthcare 2016, in reference to a Project Manager of HUS)

5.5 Potential healthcare ecosystems

The aim of chapter 5.5 is to describe the potential ecosystems that may exist in the future connected healthcare era. Firstly, all the distinct actors which may form the future IoT ecosystem in the healthcare sector are presented. Thereafter different theoretical ecosystem models are combined with results from the focused interviews. Finally, a concluding ecosystem vision, based on Fugl's (2015) and Westerlund et al.'s (2014) theoretical models, will be introduced with necessary arguments.

5.5.1 An IoT ecosystem description – distinct actors within healthcare industry

A possible IoT ecosystem in the healthcare sector was outlined to describe distinct actors within a certain IoT ecosystem. This description, illustrated in the figure 13, includes the possible customers for new IoT based solutions in the health sector such as municipal hospitals, private clinics, elderly homes and domiciliary care. Another group of actors is the technology and service providers that can all contribute to the ecosystem with their own assets. Since the health sector is still very much a virgin territory for any possible ecosystems, there will be interesting competition underway to solve which companies get to make the most impact, and which kind of consortiums and grouping will take place worldwide. It is possible, that there will be a number of leading consortiums and teaming vendors, that each take control of a certain part of the markets.

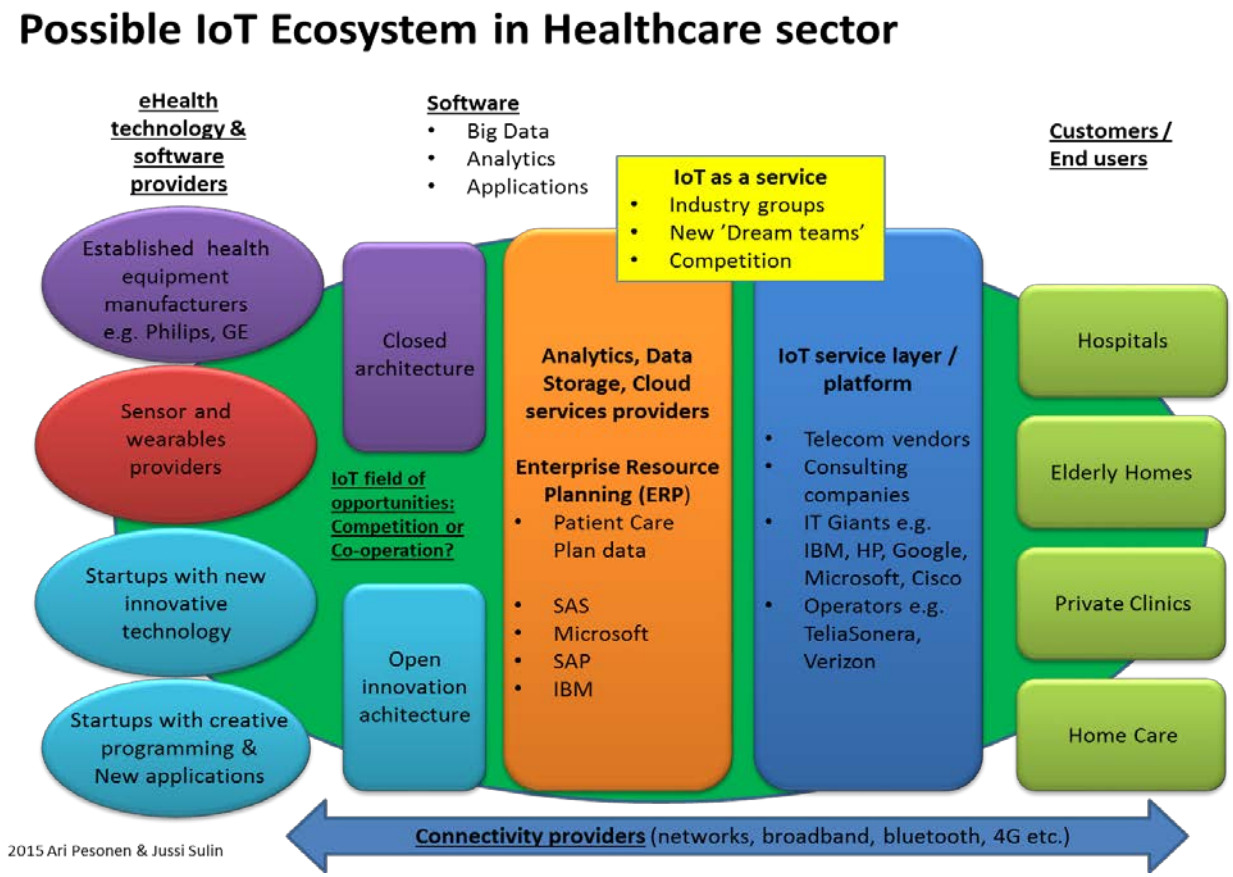

Figure 12. A possible IoT ecosystem in the healthcare sector (Pesonen & Sulin 2015)

5.5.2 IoT business model framework approach for the healthcare sector

This chapter examines the results from research interviews with the help of Business model framework suggested by Fugl (2015), which addresses the business model questions Who?, What?, How? Why?, Where? and When? from a single organization, industry, as well as an ecosystem perspective.

Who?

As regards *who?* in the IoT based healthcare ecosystem, the actors can be roughly divided into the providers and the users of IoT based solutions. Users are municipal healthcare centers and elderly homes, or their privately operated counterparts, or hospitals and end-customers such as elderly people living at home. As learned from the interviews, there are already examples of sensor technology providers teaming up with software providers who offer service packages to customers that can be either healthcare providers or end-customers directly. This kind of team-up is an example of an IoT based ecosystem in its most simplified form. When more service and feature layers are added to the service package, the ecosystem grows with more

individual actors joining it with their own niche of the business. This might be analytics, data storage or platform services to name but few.

What?

The question *What?* refers to the variety of services that can be provided with the help of IoT based technologies. The basis for most of these possibilities comes from sensoring various health data, such as blood pressure or blood sugar level from customers. This can be done remotely so that the customers do not have to leave their homes to be examined. Also movement and activity levels of the customers can be remotely monitored and the data used to make conclusions of the customer's condition. All this accumulating data can also be run through analytics and various algorithms in order to make further and more general use of it. These different uses of the gathered data provide many new business possibilities in the healthcare sector for different sized companies and joint ventures.

How?

The *How?* in this framework refers to the technological applications that produce the sensor data used for different purposes. These can be, for example, intelligent wristbands or other wearables given to the customers, or mounted sensors in apartments or hospital rooms. Mobile data devices, in turn, transfer the health data to servers and onwards to be analyzed and then stored in cloud.

Why?

Why? in this framework is essential question, because it defines the underlying motivations for any possible actors in the healthcare ecosystem. From a national economy standpoint, the evident reason for healthcare reform and implementation of new technologies is to make citizens healthier with best cost effectiveness and predictive healthcare. Aging population calls for more efficient ways of providing health services. For possible service and technology providers these nationwide objectives offer business opportunities that can also be scaled for global markets, if they are viable enough.

Where?

The *Where?* questions in this framework addresses where the value adding services are produced and consumed. This can be at customer's homes with remote measuring and doctoring. Analytics of the data is done in the servers of the analytics providers and then returned to the interested party paying for the analyzed data.

When?

The *When?* questions refers to the timeframe of developing processes and health reforms, which in Finland is estimated to be period of five to ten years. This period of time is auspicious for new startups and tem-ups to gain ground in the healthcare sector business with the help of new technology.

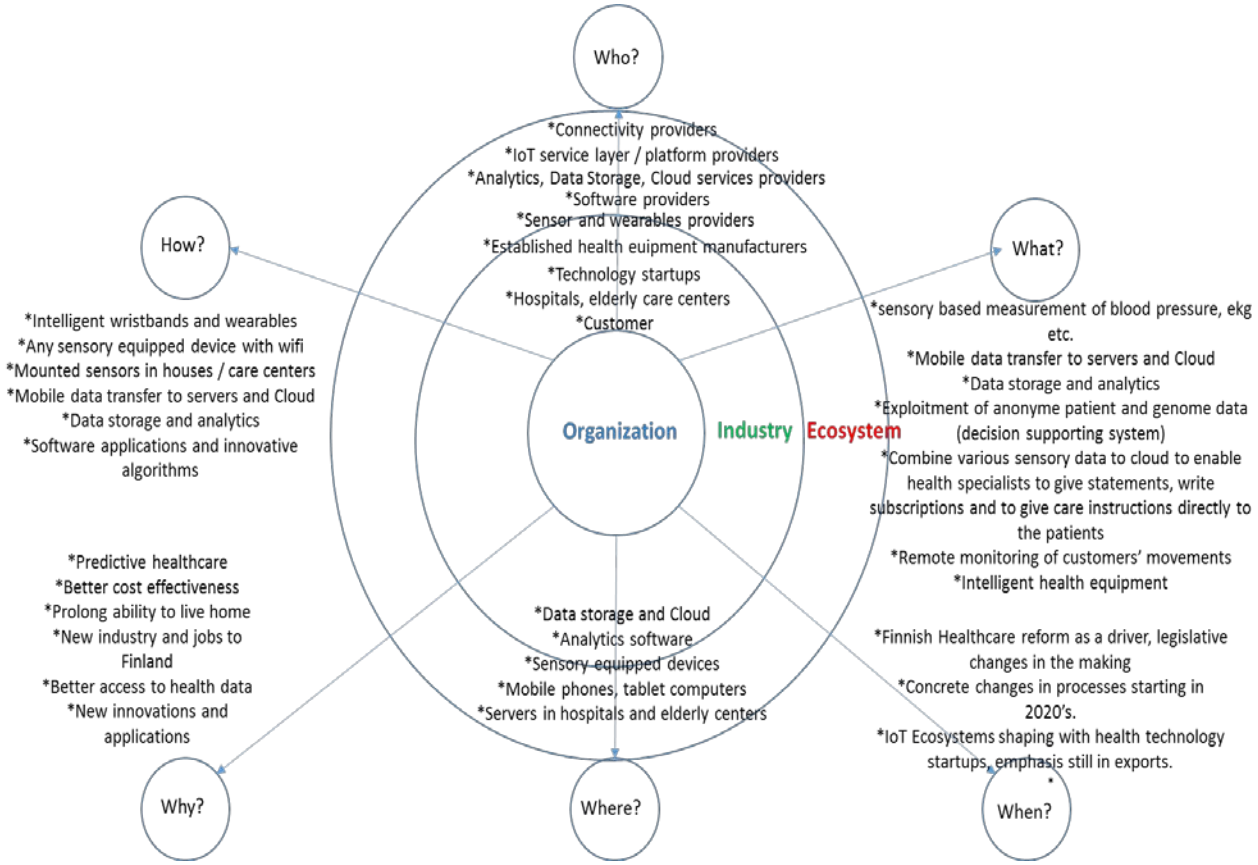

Figure 13. Proposed IoT business model framework for the healthcare sector (Modified from Fugl 2015)

5.5.3 Value Design for an IoT based healthcare ecosystem

This chapter examines the findings from the research interviews by utilizing the aforementioned Value Design tool suggested by Westerlund et al. (2014). The value elements are described from a healthcare sector perspective, and then illustrated in a composed figure.

Value Drivers

The value drivers in ecosystems depict the individual or shared motivations with the purpose of generating value, realizing innovations, and making money, and consisting of both individual and shared motivations. According to the research interviews, this study proposes that the Finnish SOTE reform is bound to be a strong motivation factor for potential healthcare ecosystem actors, whether they be municipalities and cities, or incumbent companies, or innovation driven startups. Elderly care, on the other hand is in need of structural changes because current resources are not enough to cope with the challenges of aging society. SOTE reform opens up the competition and new ways of producing health services. Within the next five to ten years the field is open to innovative and agile companies and team-ups to establish themselves as key players in the forming ecosystems.

Value Nodes

Value nodes, such as various actors, activities, or processes linked with other nodes in order to create value, are only just starting to emerge around IoT based technologies. However, there are already regional team-ups forming with sensor technology producers and software designers to offer solutions for municipal healthcare. As learned from the research interviews, open API's provide easy access to all service providers who are willing to grasp a small portion from these markets. Correspondingly, bigger ecosystems would include several equipment providers, several health specialists and so on. These solutions may be scalable in the future and may also be viable to global markets, especially with the help of Finnish government in terms of legislative improvements, economic backup et cetera.

The future top performers are the organizations that have deep subject matter knowledge and have the potential to expand their operations globally. Platform providers are already seeking viable startups with which to team up and build scalable business opportunities. Data analyzing companies will have improved business opportunities as the amount of usable anonym health and genome data will become more accessible in the future. For the care providers this provides more versatile treatment and health monitoring possibilities.

Value Exchanges

The research interviews suggest that the Value exchanges in possible IoT based healthcare ecosystems emphasize on the utilization of patient data, which generates value flows in terms of knowledge, resources and money. These value exchanges appear between and within distinct value nodes in the ecosystem. Sensor technology is utilized by gathering patient data and then analyzing it with specifically designed algorithms and software. As stated before,

the challenge is to implement unified interface for all health data to be utilized by all potential service providers.

The SOTE reform will give more regional authority to decide the allocation of funds designated to public healthcare. This in turn opens competition between public and private care providers. In the near future, as daily diagnosing and treatment functions can be partially automated, human resources will become more available for specialized care. In terms of know-how, there could be less need for general practitioners and more need for specialized doctors around Finland.

Value Extracts

Value extract in IoT based healthcare ecosystems can be described, for example, as a service package to an elderly domiciliary care customer, whose health can be remote monitored with IoT based technology. This kind of service package would also include remote doctoring and remote participation to guided activities such as exercise sessions. Revenue model would potentially be either monthly service fee model or performance based model depending on the scenario and ecosystem. Private citizens' opportunity to benefit from their individual data is bound to increase with the growing popularity of My Data -ideology, as companies will want to utilize that data in their product or service development and in marketing.

Any such actors, who will have access and/or analyzing capabilities to the increasing anonym health and genome data, stand to gain new business opportunities as cities and municipalities are looking to reshape their health services with the help of technological solutions such as automated decision support system. Furthermore, sensor based data can be used for all kinds of remote sensoring and surveillance possibilities such as 24 hours emergency service that would, for example, help elderly citizens to live home longer. Figure 15 summarizes the aforementioned value design elements.

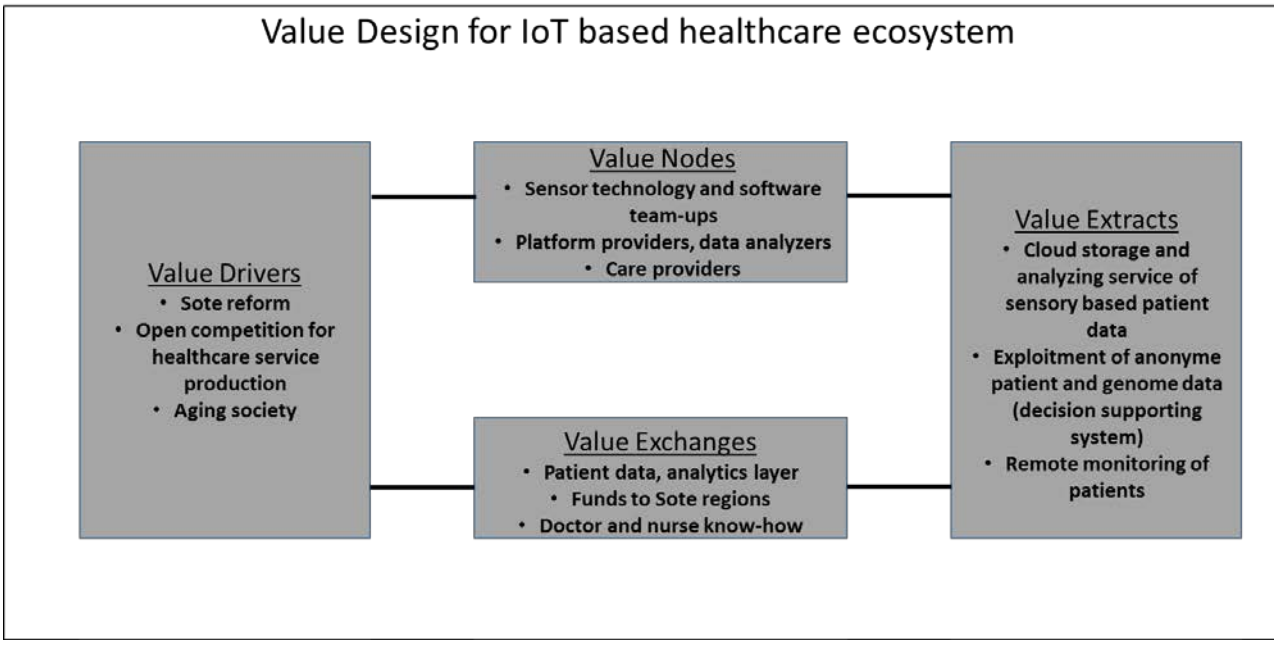

Figure 14. Value Design Tool for an IoT based healthcare ecosystem (Modified from Westerlund et al. 2014)

5.5.4 Future public sector ecosystem in Finland

The current challenges in the Finnish healthcare sector demand for structural and operational changes to cope with present and future challenges. One of the challenges is to build an efficient treatment decision making system that enables the analysis of collected health information for the purpose of evaluating individual need and urgency for treatment.

The city of Kuopio is in the forefront of such development as it is currently inviting tenders to form a network of care services that will be controlled and coordinated by the city. It includes both public and private service providers ranging from domiciliary care and cleaning services to help done by voluntary organizations. Based on this example, as well as other views of the interviewed professionals, a possible public sector ecosystem in Finland is illustrated in the figure 16. This illustration portrays a municipality or SOTE region in the center role as it controls, orders and combines services from different actors and service providers. End-customers are private citizens, hospitals and health centers, as well as elderly centers. The funding of these current and future services come from the Finnish government via SOTE regions, as well as from the customers themselves and/or from their insurance companies. In the future, the portion of privately funded health services is bound to increase as the capacity of the government is limited with aging population.

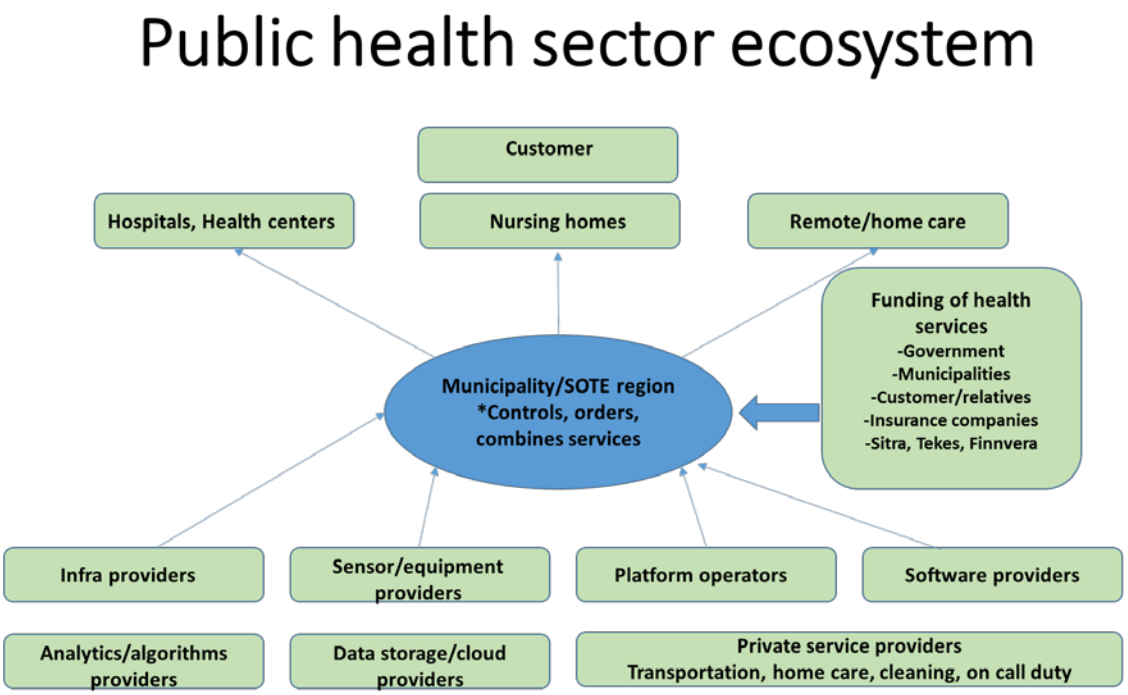

Figure 15. Future public sector ecosystem in Finland

5.5.5 Expanded IoT ecosystem framework

The next table 4 strives to conclude and expand the ecosystem framework addressed previously in this study. This ecosystem model is a combination of Westerlund et al.'s (2014) Value Design model and Fugl's (2015) IoT Business Model Framework. However, this is a high level ecosystem description, rather than an illustration of an actual existing IoT ecosystem. This is because the chosen research perspective was not to consider a single IoT business model or ecosystem, but rather to process this IoT related healthcare sector from a high-level ecosystem point of view.

Value design elements	Organization level	Industry level	Ecosystem level
Value Drivers	• Cost effectiveness • Modernization of processes • Global standards and Open API's	• SOTE reform • Renewed legislation and global standards • Jobs to Finland	• Competitive edge with ecosystems • Challenges with SOTE reform • New disruptive businesses
Value Nodes	• Startups • Health/elderly care centers	• Technology and software team ups • Government regulators • Municipalities	• Platform/infra provider • Data storage/analytics providers, solution provider
Value Exchanges	• Intelligent wearables • Mounted sensors in houses/care centers	• Any sensor equipped device • Co-creation • Legislation	• Data storage & analytics • Mobile data transfer • Standardized interfaces
Value Extracts	• Remote monitoring of customer's whereabouts • Cost savings • New business models	• New innovative software application • Intelligent health equipment	• Cloud based cross-industry predictive healthcare solutions • Exploitment of anonyme patient data

Table 3. Expanded ecosystem framework table

Value drivers depict the motivations that may speed up the development process of IoT based connected healthcare ecosystems. These value drivers, as other theoretical specifiers later, are described from the organization, industry and ecosystem level. Based on the focused interviews, the main value drivers in the future healthcare industry are related to cost-effectiveness, competitive edge through new disruptive businesses, global standards and open API's and SOTE reform.

Value nodes instead represent various actors, activities and processes linked to other nodes with the purpose of creating added value. There are various value nodes playing a vital role within an IoT ecosystem, thus the importance of each node is depending on the business scenario. For example startups, health and elderly care instances, government regulators, platform, infra, or solution providers and other technology and software team-ups are key players in many IoT based ecosystems in the healthcare sector.

Value exchanges, in turn, describe the transactions or devices needed between distinct value nodes. At organization level distinct intelligent wearables and sensors are transacting information between value nodes on an organization level. When multiple actors are involved, they intercede industry or cross-industry level value exchanges, such as co-creation, legal issues, data storage on cloud, analytics platform, mobile data transfer, standardized interfaces et cetera.

To conclude, value extracts refer to all the parts of an ecosystem, which show value that can be monetized. Starting from an organization level, remote monitoring of patients

whereabouts and new business models as such may offer monetizable solutions. From an industry level, intelligent health equipment, devices and new innovative software applications, as well as algorithms, are value extracting factors. From a whole healthcare sector ecosystem point of view, however, cloud based predictive healthcare solutions and exploitment of anonym patient data are among the most important value extracts of future IoT based healthcare solutions.

The figure 17 illustrates the expanded ecosystem vision that is derived from Westerlund et al.'s (2014) Value Design model and Fugl's (2015) IoT Business Model Framework. It aims to depict the elements of Value design from the Organization, Industry and Ecosystem viewpoints, and thus works as a tool with which emerging ecosystems can be studied.

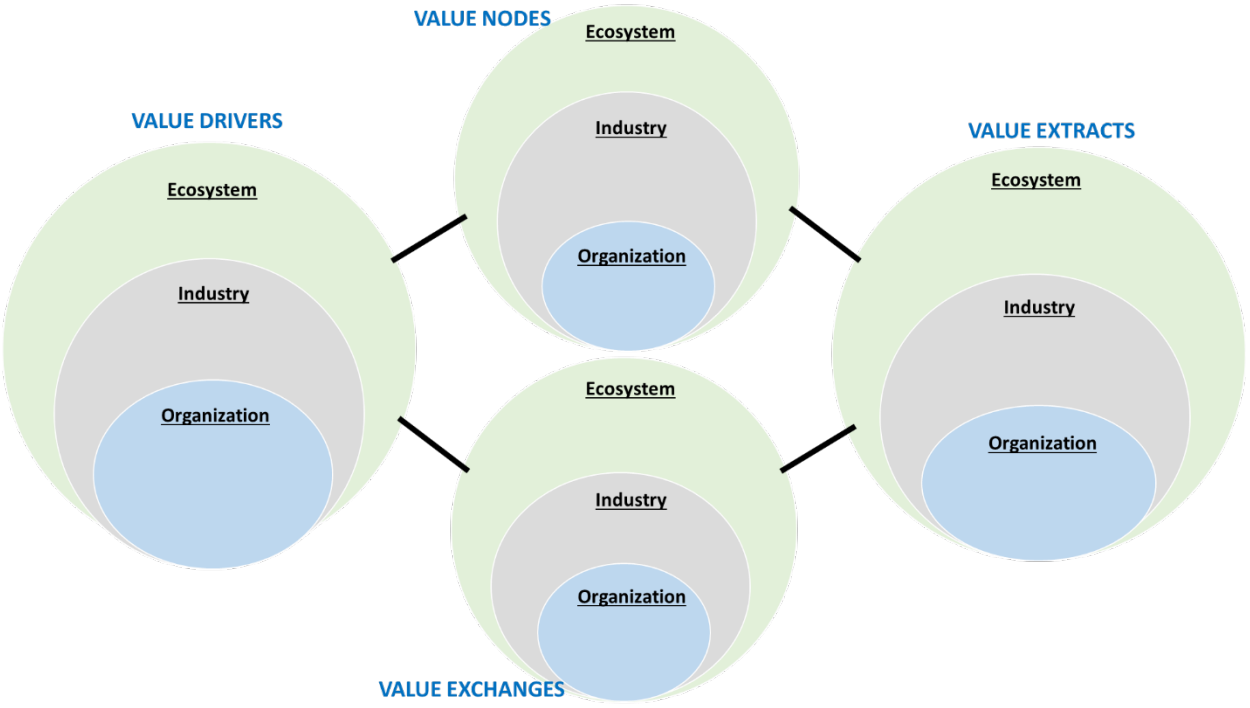

Figure 16. Expanded ecosystem vision (Modified from Fugl, 2015 and Westerlund et al., 2014)

6 Conclusions

This chapter highlights the most significant results and conclusions drawn from the focused interviews holding the ecosystem view as a core element. Next, this chapter demonstrates the reliability and validity of this study. To conclude, suggestions for further research are described briefly.

6.1 The most crucial results of the research

A change is imminent and the technology is there to help

Fortunately, most of the capabilities needed to achieve the success of digitalized services in health sectors, are in good shape in Finland. Above all, technological capabilities are on high level whereof tells a growth of new innovative startups in the health sector related to both technological devices and services. Furthermore, a high-speed communication network enables and eases new breakthroughs with digitized solutions. In addition, SOTE-reform and other initiatives aiming to streamline the legislation, will provide even more opportune operational environment to the health sector actors.

The lack of proper education may prevent the full implementation of certain IoT solutions. Therefore it is essential that educators and trainees speak the same language. It might be a noteworthy idea to recruit educators from outside the actual core development team, because engineers and nurses quite often do not share the same mindset towards technological solutions. Another aspect from employees' point of view that may slow down the digitalization in healthcare, is the resistance to change. In other words, if employees fear to lose their position, the common resistance may preclude IoT solutions in the health sector.

Value-enabling partnerships instead of excessive commercial competition

In regards to disruptive health care business initiatives, O'Riordan (2016) explains that "Many factors are catalyzing this change, including the availability of genomic, health, and lifestyle data, and an abundance of technology solutions that can help patients monitor, measure, and adjust their habits to improve their health and treatment outcomes." Surviving in this fast changing environment requires adopting new collaborative technologies and building value-enabling partnerships.

Therefore before IoT business initiatives can widely spread all over the healthcare sector in Finland, the need to adjust current processes to match the demands of new disruptive solutions, is increasingly important. In addition to processes, new technical solutions should

enable smaller niche players to easily implement their offerings to a certain ecosystem. In practice, this means that open API's enable easier access for smaller actors to provide their software applications or code to a larger ecosystem. This kind of fruitful cooperations benefit all the actors within the healthcare sector.

Different actors in the healthcare sector have varying views on what kind of business ecosystems may succeed in the connected healthcare. Global actors, such as telecom vendors, are looking for scalable solutions that are based on their know-how and infrastructure. These kind of solutions are often unsuitable for small startups due to their high initial costs and maintenance fees. The solution for them may be the emerging global communities, such as the Things Network, which constructs a global IoT data network by using a long range and low power radio frequency protocol called LoRaWAN and for short range Bluetooth 4.2. This kind of technology enables devices to be connected to the internet without 3G or WiFi and the mobile subscriptions that come with those (The Things Network 2016).

Moreover, large global players, such as Google or IBM understand that IoT solutions, often demand specific regional knowledge, as the needs and challenges are area-specific and have to be implemented accordingly with agile solutions. Therefore, it may be futile for these global companies to try and take foothold in every possible branch of business. In turn, they want to carefully choose the projects and team-ups with which to participate and leave smaller and more area-specific opportunities to smaller team-ups.

Legislation issues, and in more detailed level, distinct interpretation of laws may slow down the implementation rate of these new IoT based solutions. Furthermore, an excessive commercial competition and whitewash between distinct actors is not helping the rapid deployment of new business models. However, the pressure towards healthcare actors caused by SOTE-reform and ever-increasing co-creation initiatives may brighten otherwise sluggish development of new IoT based solutions in healthcare industry. The fact that Finland as a nation cannot cope with a fast aging society, is another factor that creates pressure to modify existing processes, and to create totally new ones.

Solution provider model highlighted

It can be challenging to find a potential business model for new healthcare related business initiatives, as there are many suitable business models, which can be utilized. However, one of the most potential is a solution provider model, which is highlighted in this study. Solution provider model means offering an encompassing package of distinct products and/or services

to the customer. In practice it would mean customized service packages, including consulting services and product elements and their maintenance. (Frankenberger and Csik 2014, 300)

Business Model Canvas helps to sketch and iterate a certain business model, as it represents a single page snapshot from a particular business model. This study included a high-level BMC drafted from a solution provider, and in particular IoT solution provider's point of view. In addition to the main bottlenecks and pitfalls, this canvas demonstrates some of the most significant action steps needed to be performed.

With the help of this health sector BMC, some of the subject matters increased their significance. The importance of acquiring good partners and having well-functioning customer relationships is extremely vital in order to deploy the business model profitably, as solution provider model rarely functions without partners. Besides the aforementioned, the possibility to co-create, co-plan or iterate a business model with other stakeholders may be beneficial to all the related parties.

In addition, revenue streams and cost structure must be carefully planned. In the future revenue logic is commonly transforming towards distinct recurring revenue models. Traditional transactional fees with large upfront payment are becoming a thing of the past. Recurring fees may even include some sort of a fee structure, in which the payment amount is based on performance and thresholds. For example, if an elderly person lives longer than expected, the municipality or relatives pay more to elderly care center. Cost structure is important in the sense that presently the price of new technology is often too high. However, as technology evolves and becomes cheaper, the chance to adjust the price to better match the customer's budget, increases.

Emerging ecosystems in the connected healthcare sector

Leminen et al. (Forthcoming, 20-22) describe three paths, how an IoT business model may emerge. *Emergence* –path is about opening the ecosystem for different industry actors and encouraging their collaboration. *Replicating the solution in multiple services* –path, in turn, describes that the likelihood for offering multipurpose services to horizontal cross-industry markets increases in the near future. The latter also increases replicated solutions and reduces the amount of totally customized services. To give an example, healthcare and the housing sector, previously totally separate industries, may offer common services solutions in the area of smart housing in the future. This type of collaboration model, with the help of IoT, may be a common way of doing business after a few years.

Last path, *Return to closed ecosystem as technology matures*, explains that IoT is likely developing first from a closed to an open ecosystem and thereafter back to closed, as technology matures. Distinct platform providers, trying to capture a dominant player role in a particular ecosystem, are speeding up this kind of development. Platform provider's role is trying to entice service providers to join the platform in order to increase their sales. Apple's AppStore is a typical example of this type of ecosystem, which will likely become more common in the health sector as well. This kind of a business model aims not only to produce cost efficiency, but also to create totally new business models by combining these different IoT applications to new services solutions. (Leminen et al. Forthcoming, 23)

Internet of Things may reshape the health sector in many ways. First and foremost, it will enable new types of actors and cross-industry ecosystems to more easily gain market position. Platform provider's role may strengthen, though not in the near future, as all the IoT based healthcare solutions need a certain platform, to which they will be deployed. Furthermore, all the big data needs to be stored somewhere, which offers distinct types of cloud storage providers a possibility to expand their businesses. In addition, telecom vendors, operators and analytics providers are likely niche players in a healthcare ecosystem, but they may also be keystone or dominant players in some scenarios. The ecosystem is likely more beneficial to all the stakeholders, when it is open. Open ecosystems comprise better opportunities for startups and it enables new types of businesses, such as co-creation.

Two theoretical ecosystem frameworks, IoT Business Model Framework (Fugl 2015) and Value Design – business model design tool (Westerlund et al. 2014) are highlighted in this study, and those have been utilized to construct a more expand view of the IoT related health sector ecosystem. This expanded ecosystem view combines the value drivers, nodes, exchanges and extracts together with the three main layers of the organization, industry and ecosystem. This theoretical ecosystem model visualizes the main results of this study to a single page, easily readable figure.

The business model tools and ecosystem models, described in this study, form a clear picture of the healthcare sector in its entirety and gives a guidance about its characteristics and action steps needed in order to achieve well-functioning business model operating in a horizontal cross-industry ecosystem. The following figure 18 concludes the expanded ecosystem findings from this research.

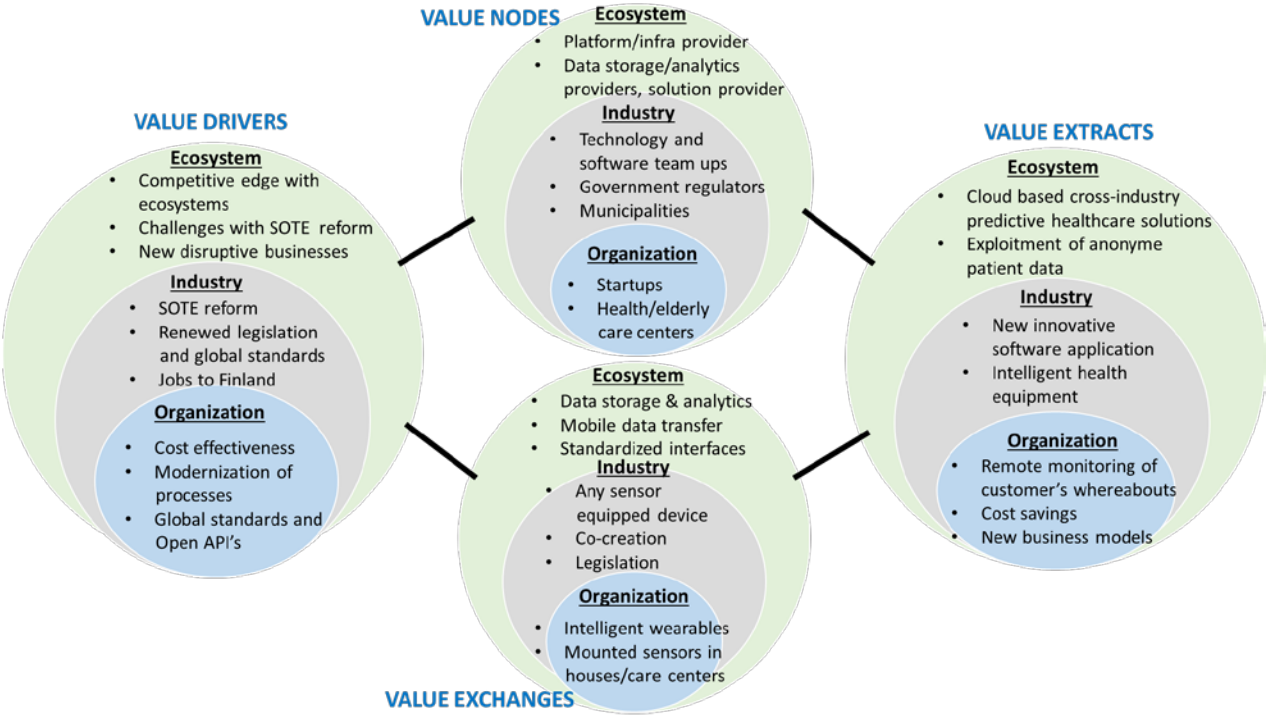

Figure 17. Expanded ecosystem view in the healthcare sector (Modified from Fugl, 2015 and Westerlund et al., 2014)

Final words

With this study we believe to have established that technology, and more precisely IoT, can help to overcome some of the current challenges in Finnish healthcare, and to innovate new services, provided that also organizational and legislative reforms are done properly within the next five to ten years. The SOTE reform is an excellent opportunity, for new and incumbent healthcare business actors alike, to take foothold in the changing business landscape. Collaboration between distinct actors comprise a strong foundation for implementing new solutions and services. Without proper input from industry actors, the nationwide social and healthcare services cannot function with same high quality service level that the citizens of Finland have been used to.

The technological know-how is already high in many Finnish cities, which should be nimble enough to implement new healthcare solutions if the offering is sensible and proves cost-effectiveness. Moreover, our study suggests that there can be viable markets for both bigger players and consortiums, as well as for smaller startups and collaborations. The interviews also suggested that regional know-how will help smaller actors to find each other to form dynamic regional healthcare ecosystems with partly customized offerings.

6.2 The reliability and validity assessment of the research

This chapter examines the reliability and validity of the research. Hirsjärvi et al. (2003, 213) explain that reliability of the research refers to the repeatability of the research results, whereas validity of the research refers to the ability of the research method to examine the things it is supposed to examine. Ethical aspects, on the other hand, refer to the integrity of the researchers as regards research results, as well as to the treatment of research subjects, and to the selection of research subject (Hirsjärvi et al. 2003, 25-28).

Preliminary measures for the interviews

The themed research interview questionnaires were formed based on knowledge obtained from previous studies, industry articles, and relevant theoretical material. The structure of the questionnaire was similar to all the interviewees, with some variations to the specific questions depending on the interviewees current position, work tasks, and the instance that they represesnt. The idea of the questionnaire was to guide the themed interviews to selected subject matters, yet without restricting the open discussion. In the selected research method the varying backrounds and experiences of the interviewees were considered an asset to the research as they were able to express their knowledge and viewpoints relatively freely.

According to Hirsjärvi and Hurme (2014, 35), interviews are valid methods for information gathering, when the subject matter is relatively uncharted and the answers of the interviewee are wanted to be placed into broader context. The subject matter of this research is relatively new to the majority of people working in the Finnish healthcare industry, although some aspects of the studied themes are known to them through their work tasks and current areas of responsibility. The selected interviewees were carefully selected to represent distinctive actors in the perceived healthcare ecosystem. It is reasonable to assume that given the same questionnaires, any other researcher would have obtained same kind of answers from the interviewees, albeit every interview is an unique event, and the personalities of the people involved naturally affect the course of the discussions. This is not, however considered a compromising matter to the results, since the objective was to create unrestricted discussions and multifaceted viewpoints from different sides of the industry.

Measures during and after the interviews

Hirsjärvi and Hurme (2014, 103) point out that the interview situation resembles more a conversation than a strict and predefined questionnaire, and that the interviewer's ability to be an active listener outweighs the importance of the premeditated questions. In this

research, the careful orientation to the subject matter helped to steer the conversations to wanted themes and directions. Furthermore, it was considered that the interviewed professionals would feel more motivated and give more indepth answers, if they were given enough information beforehand about the purpose of the interviews, as well as about the selected themes.

Hirsjärvi and Hurme (2014, 185) state that when conducting a themed interview, the reliability of the research depends on the quality aspects of the interviews, such as the clarity of the voice recordings and the concordancy of the methods such as transcription of the recordings. In this research, the interview process was conducted in the same manner for each interview. First, a customized version of the research questionnaire was submitted to each interviewee beforehand in order to give them a chance to prepare for the themed interview. Second, all the interviews were recorded with similar equipment, and later carefully transcribed from the recordings with word-to-word precision. The transcripts of the interviews were then summarized in English, with the gathering of key points and views from the discussions. Those Key points were selected reflecting the transcribed material to other information sources and with themselves.

Validity of the research refers to how competently and thoroughly it is done, and how the research results and subsequent conclusions are argued taking into account the backgrounds and mindsets of the interviewees. In order to maintain credibility of the research throughout the process, it is crucial to do critical self-evaluating constantly. This means reflecting every choice made by asking basic questions "What, Why and How?" in every step of the process. (Saaranen-Kauppinen & Puusniekka 2009, 25-28.) This research became more fruitful after every interview as the researchers' knowledge of the subject matters increased. The cumulated knowledge helped to make more indepth questions as the interviews progressed. Whatsmore, this cumulated knowledge helped to choose new additional interviewees to broaden the perspective of the research.

Leminen et al. (Forthcoming, 1) note that identifying business models in rapidly evolving fields such as the IoT based on a limited number of case studies may result in biased findings compared to large number of surveys conducted globally. However, for this study the aim was to get thorough views and interpretations from carefully selected professionals representing different sides of the possible IoT based healthcare ecosystems. The perception of possible healthcare ecosystems in Finland was intentionally started with gathering insights through selected interviews, by which the aim was, first, to perceive the current underlying needs and challenges in the Finnish healthcare, and second, to study the needs, roles and value exchanges between the possible healthcare ecosystem actors.

6.3 Suggestions for further research

More detailed real life business case study with an ecosystemic perspective

This theme could be studied further by concentrating on a concrete healthcare sector business model and the ecosystem related to it. As this study concentrates more on high-level perspective presenting possible actors, pitfalls and features et cetera, thus it would likely enrich academic conversation and expand insights within the industry. This type of micro-level research should be executed together with a certain industry actor or with multiple actors, because otherwise acquisition of knowledge might be too difficult.

Study on the detailed impacts of SOTE reform to the digitalization of care services

As the SOTE reform is one of the biggest governmental and operational method transformations ever executed in Finland, it calls for further study from numerous different viewpoints. The digitalization process of healthcare services is thus one evident subject for a further study. With the emergence of new electronical information management solutions, the traditional patient-doctor roles are expected to shift gradually. Modern concepts, such as connected healthcare, or pay-for-performance, demand for unified standards and guidelines for interoperability of personal connected health devices. This is in order to fulfill the potential for a technology-enhanced system for healthcare. Upcoming integrations of IT-systems pave a way for new digitalized business models as the amount of open application programming interfaces (API) is increasing. All these changes are relevant factors to be studied, for example, as a detailed level case study.

Study on the insurance company perspective - what kind of new business possibilities do insurance companies see with IoT?

As stated earlier in this study, insurance companies will have a significant role in the reformed healthcare industry in Finland. They have a clear incentive to invest in digitalization of healthcare, as they are one of the major net payers of healthcare costs in Finland through insurance compensations. Therefore insurance companies want to emphasize the benefits of predictive healthcare and self-made health monitoring of their customers in order to better adjust their premiums to correspond with the actual health risks of their individual customers. Some of the insurances companies operating in Finland are already starting to introduce new kind of dynamic health insurances, which are based on regular monitoring of customer's health and sustenance of a healthy life style. A further study would therefore be well argued to examine what kind of new business possibilities do insurance companies see with the emerging IoT based technology.

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Appendix 1

RESEARCH TOPICS IN THE INTERVIEWS:

1 Confidentiality questions

- Introduction of the research and the interviewee
- Publicity of the information
- Anonymity
- Permission to record the interview

2 Background of the interviewee

- Work experience and areas of responsibility?

3 Organizations's current business model

- Company's relations to IoT related business? Emphasis on health sector and elderly care?
- Who are your potential cooperation partners in the healthcare sector?
- What is your company's operating model?

4 Basic strategy for innovation and product development:

- Describe your organization's development projects and the selection process for the projects that are chosen.
- Is the selection process mainly market-drive, or rather emphasizing other channels (e.g. science communities)?
- How much healthcare related development projects do you currently have?

5 Current utilization prospects for digitalization in the Finnish healthcare sector

- How do you see elderly care developing in the near future from a technological or data usage viewpoint? In your view, which kind of health data/IoT solutions could have the biggest success potential?
    - *Will these IoT based business prospects break current industry boundaries?*
    - *Will the IoT ecosystem be open for every actor?*
- How could these IoT based solutions be positioned in the markets? What kind of pricing models can you predict?
- How do you perceive the role of foreign actors in the future? Will it strengthen?
- How do you create conditions and qualifications for competitive IoT based business in the healthcare business? Which are the key actors in the merging of future ecosystems?

- How can agile ”easy to pilot” projects be implemented in the healthcare sector? Or can they be created at all? Are you involved in these kind of projects?
- How do you perceive legislative issues (e.g. anonymity) affecting the spread of intelligent solutions in the care business?

6 Additional information

- Can you recommend some documents from your company to study?
- Have we forgot to ask something important relating to the subject matter?

Who would you recommend for further interviews?

Appendix 2

Depiction of current state with SWOT analysis

The object of this chapter is to create a summary of results conducted from the interviews. For this purpose, the results will be presented with a help of a SWOT-analysis. The idea of the SWOT is to create a single page high-level view of the most important insights gathered from the interviews.

Strengths

Current strengths from the interviewees' point of view vary depending on the organization the respondent represents. Taking these circumstances into account the following strengths related to Finnish elderly care industry emerged from the interviews:

- Remote monitoring of customers
- Scalable services
- Impartial use tests for IoT technology in the public sector
- Innovative IoT applications
- Developed sensor technology
- Mobile ERP's
- Cloud Services

The first bullet point dates back to the observations from project study conducted in the fall of 2015 by Pesonen & Sulin. In particular the public sector nursing organization envisioned that the ability to remote monitor end-customers on their premises has been a major asset for them. Nonetheless, remote monitoring more likely demonstrates even higher added value within the domiciliary care sector.

Service providers, such as solution provider, teleoperator and platform provider insight the current strengths of a national connected healthcare industry slightly more from a high level and technical point of view compared to the care provider's viewpoints. Thus those respondents pinpointed key features from domestic perspective such as, scalable services, cloud services, innovative IoT applications, developed sensor technology, mobile ERP's and impartial use tests for technology in the public sector. All these aforementioned subject matters will ease the process for the actors in healthcare industry to improve their digital offerings.

Weaknesses

Healthcare industry and even more precisely elderly care share some important industry specific weaknesses which need to be taken into account when planning a hopefully successful business strategy within the field of connected healthcare. The following bullet points introduce the most significant weaknesses conducted from interviews:

- IoT based solutions are still expensive and customized solutions are needed
- Lacking cooperation between commercial entities
- IoT does not solve non-functional processes
- IoT is still in its infancy stages
- Difficult to commit customers to PoC's or pilots

Many weaknesses are price related, which therefore makes it unadvised to underestimate the importance of proper pricing methods. Significant price related deficit is the price of technology, as for example elderly care provider B pointed out that it is not possible to gain cost-effectiveness if the price tag of digitalizing processes is too high.

Other major shortcomings detected from the interviews are either lack of competition or on the other hand, a heavy competition between commercial entities. The latter issue may prevent the best possible breakthrough for IoT innovations as the development process will be conducted by a single enterprise in secrecy, without enough cooperation with partners and other stakeholders. In addition to that, many respondents stated that the IoT is still as its infancy in Finland, and thus it may be difficult to commit potential partners or customers to PoC's and/or pilots and furthermore lure adequate enough resources to these projects. Last but not least, many interviewees addressed that digitalization or IoT does not solve bad processes, but rather the processes need to be streamlined to match the demands of connected healthcare.

Opportunities

The interviewees had many common ideas regarding opportunities that digitalization and IoT may enable within healthcare and elderly care industry. Although the amount of diverse viewpoints was quite high among the respondents, it was still possible to separate some most significant themes, such as:

- Aging society – a need to prolong the ability to live home
- Mobile access to patient data
- Common standards – global communication interface in the future
- SOTE-reform
- Utilization of health data vs. My data ideology

- Deduction of household expenses to cover personal healthcare costs
- Safe area movement within elderly center premises
- Remote monitoring and remote doctoring – domiciliary care as a forerunner

As societies are aging in many western countries, the pressure to innovate new type of digitized services in elderly care business may fasten the paradigm shift from old business models to new omni-channel business models. In Finland SOTE-reform enforces the whole industry to mirror its current activities and as a result to improve its services. IoT and digitalization are most likely one solution or aid to modernize the Finnish healthcare and wellness services.

Remote monitoring and distance doctoring will become more common in the future and the amount of new services should increase, which offers opportunities for both incumbent enterprises and new startups. The ever-increasing quality and speed of mobile network provides possibility to make use of mobile data, such as patient data, generic health data et cetera

Common standards, like global communication interface, open API's et cetera, could ease the market entry for small startups as they could offer standardized services or applications to customers without the need to tailor every single solution separately. On the other hand by incorporating deduction of household expenses to cover healthcare costs, it may cause modifications to current business models, as the end-customers might be willing to invest more to health related issues.

Threats

The most consequential threats from the research objects' point of view are related to distinct privacy, security, legislation and process related matters. Within these topics yet open questions are:

- How data security and privacy related issues will be handled?
- How legislation and processes keeps up the speed with racy utilization of connected healthcare solutions?
- Is global and domestic healthcare industry able to create common standards which eases and expedites the development of IoT based offerings?

By solving these yet open threats in a manner that benefits the actors within industry, it is possible to gain competitive edge and solve the sustainability gap which exists in many western countries, such as in Finland. Ever-increasing big data capabilities added by open

API's offers a perfect basis to innovate new digitized IoT-solutions in a manner that solves those aforementioned possible threats.

SWOT table of results

The table below presents an overview of the results in form of a SWOT-analysis. This SWOT pinpoints that domiciliary care will most likely function as a forerunner regarding the IoT and digitalization in the elderly care business. For example, if an elderly person could stay home longer than nowadays, the impact to domestic social- and healthcare costs would be surprisingly significant.

SWOT

Respondent	Strengths	Weaknesses	Opportunities	Threats
Helsinki based public elderly center	Remote monitoring of patients	Expensive, customized solutions needed	Safe area movement, mobile access to patient data, remote doctoring	Privacy and security issues
Chief Medical Officer (CMO) of the city of Helsinki	Remote monitoring of patients	Commercial entities in competition (cooperation missing), effectiveness of pilots	Prolonging the ability to live at home	Privacy and security issues
Telecom vendor's Innovation Advisor	Experience and established actor in different industries, partnerships	Expensive, customized solutions needed	Safe area movement, mobile access to patient data, common standards	Privacy and security issues, lack of common standards
Development Director of Private Elderly care provider A	Ensuring safety around premises, virtual and training services	Does not solve non-functional processes	Mobile registration of patient data, more flexible care solutions	Privacy and security issues
Quality and Development Manager of Private Elderly care provider B	Healthcare and domiciliary care as trendsetters (remote monitoring, mobile).	Expensive, no cost-effectiveness to be seen with implementing new sensor technology in nursing homes	Remote monitoring and distance doctoring, domiciliary care as a forerunner	Cost-efficiency partly bound to staff regulations
Technical Director of equipment provider	Remote monitoring, predictive	Lack of competition weakens visibility to potential customers	Standard global communication interface in elderly	Lacking common standards, bulk devices, processes not matching the

	analytics and cloud services		care industry, aging society	demands of connected healthcare
Junior Development Manager of Teleoperator	Scalable services, mobile ERPs, impartial use tests for technologies in public the sector	IoT still its infancy in Finland, willing early adopters hard to come by, resource planning in IoT related projects	New business models, virtual technology, My Data ideology, global markets with startups	Lack of common standards, lack of resources and technology centered approach
Senior Advisor of a Finnish Innovation fund	Innovative applications for home diagnostics and domiciliary care	IoT still finding ground in Finland, networking and joint operations often in infant stages	SOTE reform - new opportunities for startups, utilization of generic health data, deduction of household expenses	Privacy and security issues, sluggish streamlining of legislation
Senior / Junior Specialist of a Kuopio based Innovation company	Domiciliary care solutions, sensor technology in Finland.	IoT still finding ground in Finland, old operating models and ways of thinking	SOTE reform - new opportunities, standardization in sensor devices, open API's	Privacy and security issues, funding for projects

SWOT analysis of the research results

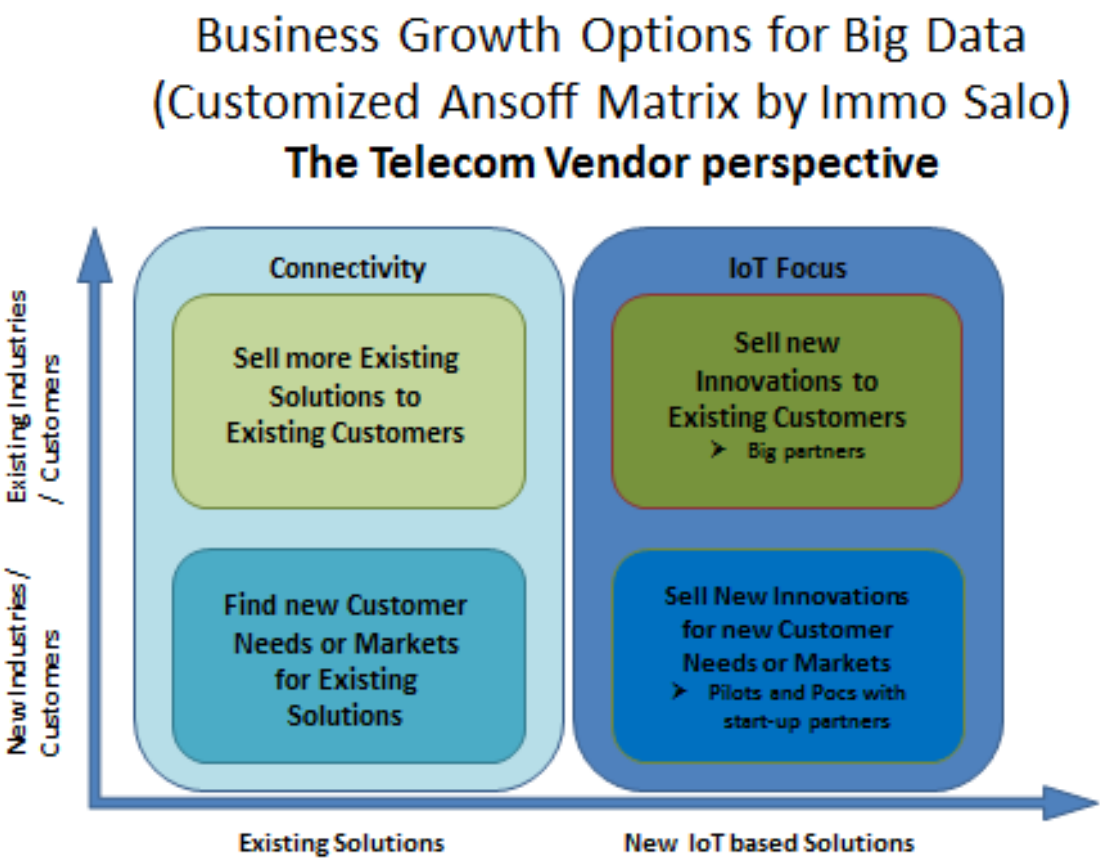
Appendix 3

Ansoff Matrix with IoT focus

The findings from the telecom equipment provider perspective on the IoT business opportunities was decided to be illustrated by the means of a customized Ansoff/Salo matrix, presented in the figure below. It describes four different paths for seeking market growth. In telecom provider case we see them as being *1) selling more existing solutions to existing customers, 2) finding new customer needs or markets for existing solutions, 3) selling new IoT based innovations to existing customers and big enterprises and 4) selling new IoT based innovations for new customer needs or markets through pilots and POCs, and with collaboration with startups.*

The IoT Focus for a Telecom vendor for existing customers could mean applying sensors and utilizing sensor data in manufacturing industry in order to help streamline operations and thus seeking cost effectiveness. Alternatively, the utilization of big data and sensors could also help spur new business models for established companies. The role of the Telecom vendor could be building the platform for partner companies, in addition to providing the connectivity.

New technological innovations are often made by new startups rather than by established companies. The ideal IoT based ecosystem for healthcare business could include a telecom vendor building the suitable platform for new companies and perhaps enabling open innovations, whilst providing the connectivity. Individual technological innovations are important in the healthcare sector and may help new companies establishing themselves in the industry. However, the real potential to change healthcare business comes from innovative ecosystems and dream teams that can offer a new way of thinking and managing healthcare in the future.



Business Growth Options for Telecom Vendor (Customized Ansoff/Salo Matrix)