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PEOPLE'S PERCEPTION OF DIGITAL HEALTH SERVICES IN ESTONIA - APPLIED RESEARCH

Master's thesis

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MSc, MMS

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TALLINNA TEHNIKAÜLIKOOL
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INIMESTE VASTUVÕTLIKUS DIGITAALSETELE TERVISE-TEENUSTELE EESTIS – RAKENDUSUURING

Magistritöö

Juhendaja: Riina Hallik
MSc, MMS

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Author’s declaration of originality

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

Author: Urmo Lehtsalu

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Abstract

The aim of the thesis is to understand the perception of digital health services and people's willingness to pay for such services. To best address the aim, the following objectives were defined:

1. Define potential customer groups for digital health services
2. Validate these groups on health experts
3. Identify people's perception and willingness to use digital Health services
4. Define possible value proposition of digital health services
5. Validate those service offerings on customers
6. Explore the willingness to pay for such services

Reaching the set objectives, the author chose applied research as the most suitable quantitative method, utilizing in-depth interviews with experts and potential end-customers. This method was selected to best capture personal perceptions and opinions of interviewees. The results of the thesis suggest strong support for digital health services, with 95% of the respondents ready to use such services and 80% of them preferring advanced paid service levels instead of free and simple applications. The authors' main conclusions include' that digital technologies are well accepted, and people are willing to pay for digital health services.

This thesis is written in English and is 47 pages long, including 6 chapters, 7 figures and 8 tables.

Annotatsioon

Inimeste vastuvõtlikkus digitaalsetele terviseteenustele Eestis – rakendusuuring

Käesoleva magistritöö eesmärk on välja selgitada inimeste vastuvõtlikkus digitaalsetele terviseteenustele ja nende valimisolekule selliste teenuste eest maksta.

Töö eesmärgi saavutamiseks on magistritöö jagatud kolme ossa. Töö esimene osa võtab kokku teoreetilised alused, sealhulgas tervisemõjurid, tervisekäitumise ja terviseinformatsiooniga seotud teooriad. Lisaks käsitletakse inimeste tehnoloogia vastuvõtlikust ning teenuste arendamise aluseid ja maksevalmiduse teooriaid. Lisaks tehakse ülevaade varasematest uuringutest nii Eestis kui maailmas.

Teine osa töös defineerib ära tööprotsessid ja kasutatavad metoodikad. Lähtuvalt töö eesmärgist, valis autor töö teostamiseks rakendusuuringu kui parima kvalitatiivse töömeetodi antud uurimisteema lahendamisel. Tööprotsess koosneb ühest ringist erinevate valdkondade ekspertide ning kahest ringist lõppkasutajate süvaintervjuudest. Lõppkasutajate intervjuude kahe ringi vahel viiakse läbi vastuste kodeerimine ja andmete analüüs, mille tulemuste põhjal luuakse teenuskontseptsioonid kasutajaintervjuude teise ringi tarbeks. Loodud teenused valideeritakse lõpptarbijate peal ning teise ringi tulemuste pealt hinnatakse inimeste vastuvõtlikkust digitaalsetele tervise teenustele. Eraldi peatükk käsitleb maksevalmiduse teooriaid, millede alusel uuritakse kas ja kui palju inimesed on valmis selliste teenuste eest maksma.

Magistritöö kolmandas osas antakse ülevaade läbiviidud uurimustöö tulemustest. Kokku jõuti kuue ekspertide poolt valitud potentsiaalse kasutajagrupini, kelledeks on fitness noored, hobisportlased, noorte laste vanemad, keskealised, töönarkomanid ning

tervislikud vanemad inimesed. Neile esitleti loodud teenuskontseptsioone, milledeks on Meelerahu programm, Cardio treeningu programm, Hea une programm, Haigusseisundi jälgimise programm, Terviseaudit ning Konsultatsioon eksperdiga. Defineeritud teenustele loodi neli hinnataset: Tasuta, Soodne, Keskmine ning Parim tase, kus iga järgmise tasemega tuli seadmeid, andmeid ja füüsilise inimese kokkupuudet teenusega järjest juurde. Hinda teenustel küljes ei olnud, selle asemel küsiti intervjueeritavalt „Kui palju sinu hinnangul selline teenus maksta võiks?“

Ainult üks intervjueeritu ei soovinud ühtegi teenust, kuna see 64 aastane vanem meesterahvas usaldab terviseasjades ainult oma perearsti. Kõik teised vastanutest olid valmis tarbima ühte või enamat neile pakutud teenustest, mis autori hinnangul viitab positiivsele vastuvõtlikkusele tarbida digitaalseid terviseteenuseid. Kõige populaarsemaks osutus terviseaudititeenus mida soovis tarbida üle poolte küsitletud inimestest ning mis võimaldaks inimestel saada ülevaate oma tervise hetkeseisust. Kommentaarides ütles enamus intervjueeritutest, et kuigi nad ise tunnevad ennast hästi, siis neil ei ole kuigi head ülevaadet oma tervise objektiivsest seisust. Kõikidest inimestest, kes olid valmis teenuseid tarbima, 80% sooviks valida pigem põhjalikuma ja tasulise teenuse, mitte pinnapealsemat tasuta versiooni, mis näitab suurt valmidust tasuliste teenuste tarbimisele. Eksperdi olemasolu paketis ja andmete tõlgendamine eksperdi poolt, olid peamised põhjendused, mis toodi tasulise taseme kasuks. Ilma eksperdita sooviks ise tehnika poolt kogutud andmeid mõtestada 20% vastanutest, kes olid selliste andmete ja teenustega piisavalt kokku puutunud kas läbi sportimise või oma haiguse kulgu pikka aega jälgides.

Kokkuvõtvalt hindab autor, et inimesed on positiivselt meelestatud ning vastuvõtlikud tasulistele digitaalsetele terviseteenustele, kui sellega käib kaasas ka ekspertnõu reaalselt füüsiliselt inimeselt.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 47 leheküljel, 6 peatükki, 7 joonist, 8 tabelit.

List of abbreviations and terms

APP	*Application*
ID	*Identity*
IDC	*International Data Corporation*
IoT	*Internet of Things*
IPTV	*Television service provided over internet*
IT	*Information technology*
HCT	*Health Care Technology*
TUT	*Tallinn University of Technology*
TV	*Television*
WHO	*World Health Organisation*
WTP	*Willingness to pay*

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1 Introduction

In recent decades, medical grade technology has received a scientific and developmental boost, bringing much-valued health data to help cure people in case of health incidents. Whether it is a one-time unexpected hospitalization or on-going treatment of chronic disease. As Dahlgren and Whitehead [1] suggested, persons health is more determined by individual lifestyle and community networks and healthcare system counts for about 10% of ones' health outcomes [2]. Surroundings and personal behavior accounts for 70%, out of which 20% would be put on the environment, and highest weight of 50% would be accounted for lifestyle and personal health behaviors [2].

These numbers suggest that from a health promotion aspect the focus should be on guiding health behaviors through helping individuals to make good health-related decisions. There has been health education and communication but hardly on a personal level as there was not enough personalized health data available. Fast development of digital technology and wearables over past years have brought sensors and all kinds of measuring devices to private homes, to the individual level, that previously were available only on medical institutions. Providing an opportunity to digitally gather and use data also about those 70% of health determinants that previously were not possible. Statistics shows the increase in wearable devices and sensors shipments has grown ten-fold in four years [3]. Quantified self as a movement [4] has utilized the moment and showcased a boost when using those technology gadgets arriving at the market and digitalizing wellbeing information. International Data Corporation (IDC) adds a forecast with another 100% growth by 2021 with biggest growth categories as clothing and earwear [5], making personal level health sensors a commodity to all of us. Defining service offerings later in the thesis considers such market development as an enabler of automated monitoring and will not focus on specific sensors and in their availability.

Even though medical,wellbeing and sports data are available in electronic form, there still have not been many services that would combine the data into a service. If one would add the three levels of data (medical, wellbeing and sports/fitness data) into one holistic picture, then theywould complement to the more holistic, yet personalised health approach which would help people to make better health decisions and potentially stay healthier longer.

Previous research in Estonia deals with health and fitness technologies' potential use in prevention [6], how healthcare companies identify technology-based opportunities [7], and also the usability study of current digital health services [8]. They all saw potential benefits from the application of digital technologies, however concluded that more systematic approach for technology involvement along with developing customer focus is needed to speed up the uptake and have better usability. World Health Organisation (WHO) is the leading research and cooperation contributor in the world, and in it's "From Innovation to Implementation" report pointed out that eHealth has played a vital role in expanding access by helping to overcome physical distance, improving coordination of care,patient management and most importantly empowering people to beengaged in their own health and wellbeing [9].

Estonia is an awarded digital innovation country. Estonia's e-Residency is one of the latest innovative "game-changers" as Edward Lucas puts it, is - it allows anyone in the world to have a government-backed digital ID [10], that leads them into the open market of digital services. The Telia Eesti and Samsung joint development of the world's first IPTV APP in connected TV as another example of digital service innovation importantly proved that one of the largest technology producers in the world trusted Estonia as a development base for their technology [11]. The Estonian electronic health record with eHealth portal which involves all the healthcare service providers in Estonia provides an example of innovation in digital health services [12].

The above examples support Estonia as the best place to research digital health services and peoples' perception on those. Even though small in size, Estonian digital impact is reaching around the world. The underlying question inspiring this thesis topic was, that: "Are Estonians also open for digitizing all of their health and fitness services?"?

1.1 Research focus

The current thesis is conducted from a customer perspective and will focus on possible added values from technology usage in the health domain and customers' willingness to use health-related services through digital channels.

This thesis focuses on studying customer perception of digital health services. Such a study requires combining the background of individual perceptions in general, perceptions of health and health determinants, acceptance of digital technology and personalization of digital services. For customer perception, the underlying concept will be based on health behavior and technology acceptance theories. Willingness to pay is studied by combining subjective and monetary pricing theories.

The thesis is limited to above-declared focus and will not study any specific health-related services, deeper technological aspects of health domain, business models in the health domain, risks in digital health services and risk perception by consumers, or legal constructions and limitations. These aspects would be valuable follow-up research to complement the eHealth domain as a whole.

1.2 Aim and Objectives

The aim of the thesis is to understand the perception of digital health services and people's willingness to pay for such services.

To best address the aim, the following objectives were defined:

1. Define potential customer groups for digital health services
2. Validate these groups on health experts
3. Identify people's perception and willingness to use digital Health services
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1.3 Value of this research

There is research available about Health Care Technology (HCT) from a Medical and Health Care perspective and also from a high-end technology innovation perspective [7]. There is not much research available from end-users' perception of digital health-related services that would be validated on actual customer groups. Therefore, this research asserts to add another perspective to the health domain. Studying the end customers perception and also willingness to pay for those services.

The thesis is relevant for health information collectors and digital health service developers, starting from start-ups up until the national discussions of future health services as it seeks to provide real-field customer-centric results. On top of the research value, the results will be a valuable input into the national discussion on health information and information-based digital health services, providing direct feedback from end-users and their expectations on digital health services.

1.4 Content

The thesis is written in English, although the empirical thesis research was conducted in the Estonian language in Estonia, engaging as a representative sampling of the population as possible. The content is divided into three parts. The first part involves the theoretical foundations of health determinants and behavior, followed by technology acceptance and willingness to pay theories. The second part describes the research process and methodology, with the primary focus on conducting the interviews and analysis of data. The third part covers results of the interviews with a description of limitations.

2 Background

There are several definitions of health and (digital) health services. Therefore, in the following chapters, an overview of principal topics and theories will be given, that will define the rest of the research.

Digital Health Services, that are the main subject of this research, in this thesis are defined by author as information-based services that are delivered over any digital channels. Such services use scalable and interactive technologies to assist or guide a person towards better health decisions and outcomes.

For such research, background on health and health determinants, health behavior and behavior change, technology acceptance and willingness to pay has to be combined.

2.1 Health and health determinants

Health, as defined by WHO is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [13]. In this thesis, both mental and physical aspects of health will be studied, yet more from the wellbeing and health promotion perspective and less from a disease or infirmity perspective as this would go too far into medical domain.

Lifestyle or personal health behavior has been stressed as the main determinant of ones health, besides social and community bonds [1]. Personal contribution as a determinant of one's health has been growing in recent studies [2] and explained on Figure 1. Working with Health Information has been correlated with increased health knowledge and therefore healthier lifestyle decisions [14].

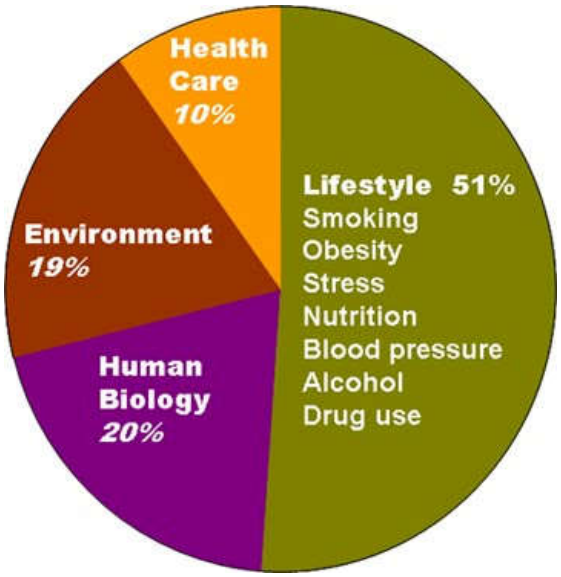

Figure 1. Social Determinants of Health. Source: Jennifer Richards.

Individual lifestyle factors include, but are not limited to Medical Health Care, human biology, and lifestyle-related health behaviors like nutrition, fitness, and sports, but also environmental factors and states [2].

2.2 Health Behavior

As explained in the previous chapter, health behavior is one of the most important health determinants. Health Belief Model emphasizes' the importance to persons beliefs and perception of possible health outcomes to health behavior and long-term motivations [15]. Ajzen adds on top of beliefs also attitude, subjective social norms, and perception of control as contributors to health behavior [16]. The transtheoretical model describes how people see the change in their health behavior and why the shift towards healthier habits is sometimes failing [17] and also proposes six stages of health behavior change.

These three models stress the importance of individual perception in health behavior. In this thesis, peoples willingness to make a change in their current habits will be studied as proposed by the Transtheoretical Model and also questions on peoples long-term motivations will be included as suggested by Health Belief Model.

2.3 Health information and security

Health data is the core of digital health services. Decisions based on data, rely on information behaviors three steps - identifying the need for information, searching for information and using information. Whereas identifying the need is the understanding the lack of knowledge, seeking information is a response to cover the gap of information and using information is applying the search results to increase the awareness [18].

Health Information that underlies digital health services has multiple definitions in different research. The most suitable wording for this thesis would be "something that either reduces uncertainty or changes one's image of reality" [18] even though, Case himself explains information as a primitive concept that needs no singular definition as something too difficult to describe.

Interactive technologies like web services or mobile applications are easily scalable, and content of such services is possible to customize for individual needs. A Personalized content that fulfills consumer's unique requirements [19] can be targeted dependent on (populations) socio-demographic or health behavior characteristics and emotional or psychological factors, to attract attention and enhance motivation to use new technologies [20].

Use of interactive digital technology is allowing more significant personalization as described by Pine in his Experience Economy [19], [21]

Pines' model describes how services have to become more and more customized to stay relevant or they will be commoditized and taken over by competition. With Figure 2, Pine explains how each upper service level increases the satisfaction of customers, also giving more loyal customers and more profit to the service provider as. By his model, the most satisfying service would encourage and guide its consumer from who they are, into who they would like to be. This guiding can be done by regular personal meetings with health experts or with the help of digital health applications. One of the examples of using digital tools is a Quantified Self concept [4] and people within this movement, who are applying a lot of technology for more precise data to get most customized services.

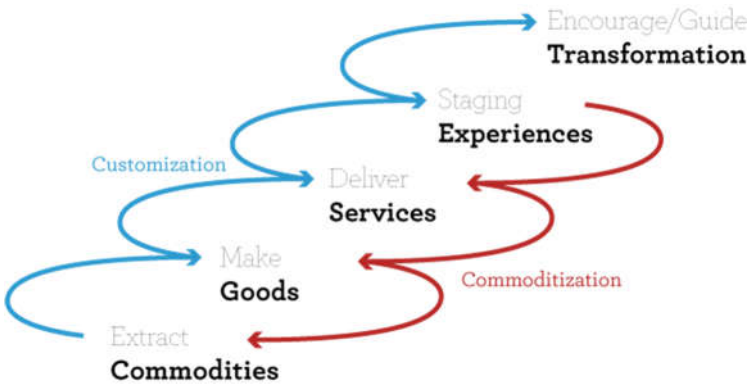

Figure 2. The Experience Economy. Source: Joseph Pine.

On the one hand, the service opportunity for an entrepreneur exists when they can offer a service more effectively at a better price, or they find a new technology or new business model, and there is actual or potential demand for that service by individuals or groups of individuals [22]. But on the other hand, consumers should accept the new technology and entrepreneur has to study consumers' willingness to use new innovative technologies. Evaluating person's technology acceptance could have either subjectivist, structurationalist or objectivist approach [23] dependent on perspective. In this thesis, the subjectivist approach is preferred to focus on the individual and to best capture perception, behavior, and other personal factors.

2.4 Technology acceptance

Accepting the technology is the first step a person has to take before starting with a new digital service. The User Acceptance of Information Technology theory [24] generalizes multiple technology acceptance theories. According to Venkatesh the acceptance of technological solutions is based on behavioral intention and individual reactions. This subjective model defines personal relevance, perception, and intentions as primary contributors to technology adoption. Venkatesh has aggregated eight influential theories that also include essential psychological Theory of Planned Behavior [16] and Diffusion of Innovation Theory [25] that will also be underlying this thesis.

Ajzen [16] concludes that motivation and personal beliefs are underlying behavioral factors that help to predict the health technology acceptance. People are more likely to accept new technology when they believe to have clear motivation through seeing the benefits and when they perceive the new technology is not too difficult to use. Also,

essential belief factors are the subjective social norms - what people, important to us think of this new behavior and either people perceive enough behavioral control towards that new technology.

Rogers Diffusion of innovations theory [25] also has a subjective approach in technology acceptance study. Rogers proposes a diffusion as a process how new technologies are accepted and adopted within a society. The model describes how innovators and early adopters are the ones to take new technologies most naturally and the majority of society would need more time and different communication channels for their subjective perception of new technologies as beneficial enough to accept the changing complexity. This model seeks to explain the customer segments with their main characteristics and suggest not to address all population at once with innovations but to target segments more specifically and maybe with different communication channels as visible in Figure 3. In this research, it is a valuable tool to select the services to propose to various groups and while choosing the right customer groups to target with interviews.

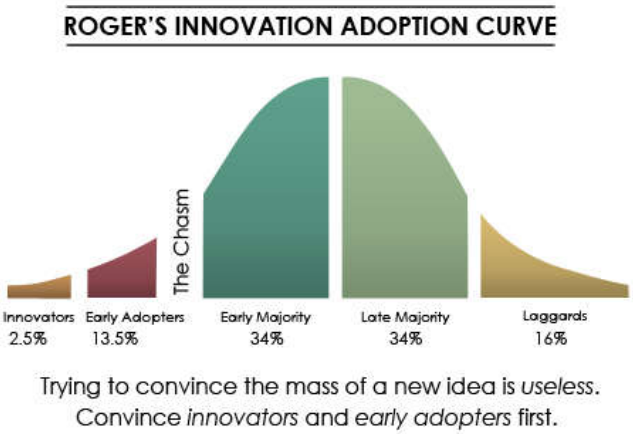

Figure 3. Diffusion of Innovations. Source: Everett Rogers.

Companies are continuously conducting technology reviews in different domains. Using innovative technologies leads companies towards cost effectiveness, improved quality, upgraded products or altogether to new products and services [26].

While it takes time for an idea to get to the reasoned concept and then to develop into business viable product or service, Gartner Hype Cycle [27] is one of the leading tools to compare the maturity of emerging technologies and applications visually as presented in

Figure 4.

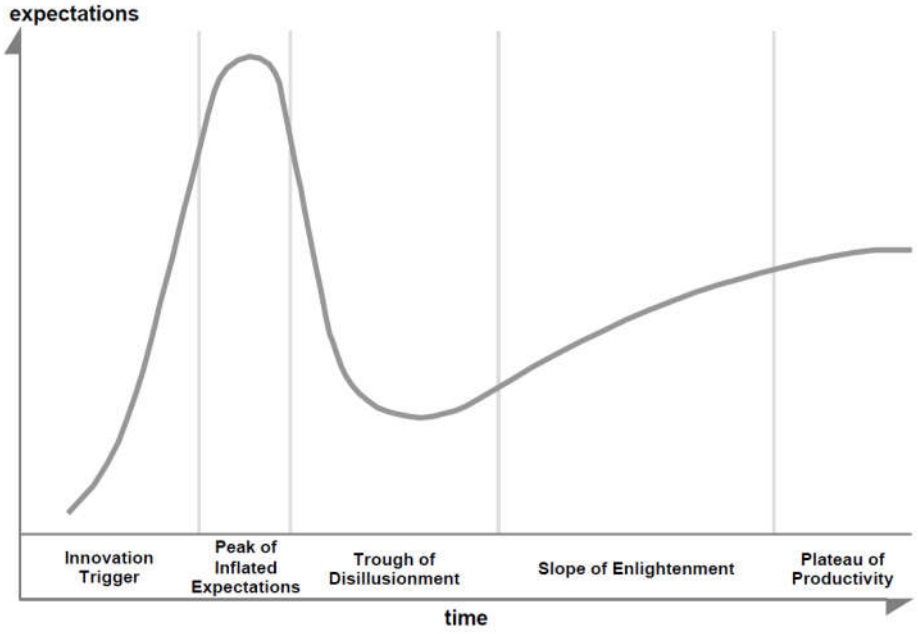

Figure 4. Gartner Hype Cycle. Source: Gartner.

This methodology provides an independent evaluation of bold promises of new technologies and how viable they are to solve ones' real business needs today or in the future. Each year Gartner technology analysts place the emerging technologies into their hype cycle curve, that is widely used the input to find or validate one's technology investment theses. In 2014 Hype Cycle, Quantified Self was one of the fastest advancing and most promising applications of innovative technologies to be expected in real life. Giving much credit to devices and services that had anything to do with one's personal health measurements, recordings, analyses. While Hype Cycle gives indications and compares different applications, Gartner has also developed The Magic Quadrant [28] tool to compare similar services by "completeness of Vision" and "providing companies' ability to execute that dream" axes. The Magic Quadrant is a widely used tool while positioning and comparing (digital) services. In the thesis at hand, Hype Cycle was used as reference opinion to evaluate the readiness of digital health services and Magic Quadrant will be used to define service offerings.

2.5 Service development

One of the most prevalent methods for service development and validation is Lean Startup model by Eric Ries [29]. Ries is heavily customer focused and suggests not to design services from technological opportunities, but from a customer needs perspective and

business expectations aspect. It is recommended to have short and fast iterations as expressed in Figure 5, instead of preparing a long time for one shot. This is a suitable method to understand the actual needs of customer groups and continuously co-develop a service with your customer.

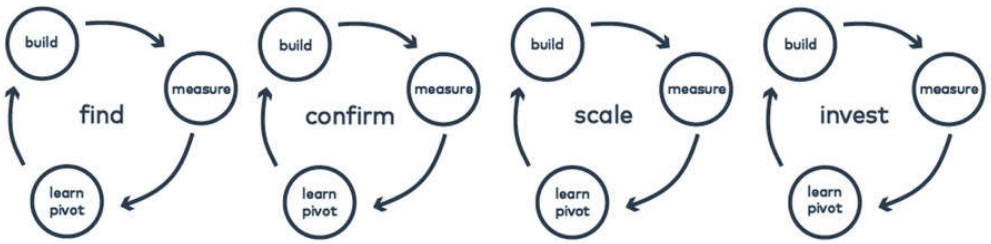

Figure 5. Lean Startup Development Process. Source: Eric Ries.

While Ries proposes a working method towards customer needs, Osterwalder in his Value Proposition Design [30] adds more detailed steps how to get from customer segment defining to Value Proposition and how to evaluate them. In the thesis Osterwalder model will be used until value propositions are reached using Ries iterations method, and the rest of the model is out of the scope of this research.

IoT Ecosystem concept [31] from Telia Eesti is connecting different domains into a single pool of digital services presented in Figure 6. This model divides hardware, business services, and customer services into three separate layers. The concept is consistent with Latour's' Actor-Network-Theory [32] where relations between actors are more important than other parameters of those actors. Named approach allows mapping of relationships between actors like devices and customers and doctors for example. In the current thesis service development will follow the same vendor independent and layered approach to define the services.

Figure 6. IoT Service concept by Telia Eesti. Source: Telia Eesti.

2.6 Willingness to pay

Besides perception of digital services, the additional research question in the thesis is either people are willing to pay for such services by themselves or are expecting to have such services for free or somebody else paying for the services.

Willingness to pay (WTP) expresses monetary terms that reflect the amount of money people are willing to pay for positive health outcomes [33]. Osterwalder suggests studying customers willingness to consume a service through subjective pricing as "less expensive" and "more expensive" product [30] to keep the focus on the perceptive value of the product and not to terminate the customer by the exact price. Martin Lindström added the gap between peoples expectations and actual purchase decisions [34]. In current thesis WTP will be studied combining Osterwalders' subjective pricing first, followed by Drummonds' guiding's for monetary terms and having two rounds of different type of interviews provides a foundation for evaluating if peoples stated expectations in the first round would correlate with their service preferences decisions in the second round.

2.7 Results from previous research

WHO is leading the worldwide research and cooperation in health and eHealth domains. Their eHealth report [9] pointed out increasing appetite for eHealth in the European region. As most of the countries covered by the study reported to have national electronic health records in place, WHO recommended to focus the future research and development into deeper personalization, new analytical methods and on the appropriate and constructive use of social media for health-related topics. The report saw privacy and lack

of integration between organizations as leading barriers to involving more data in health management and therefore recommended robust legal framework focusing on confidentiality, ownership of data and data sharing to be defined.

In Estonia, Pille Muni studied health and fitness technologies' possible use for disease prevention [6]. The study found new digital technologies to be one of the largest possible change makers in the health services and especially in the prevention field. Muni found the gap between actual technology usage and possibilities to be huge and technology in general well underused in occupational health organizations and prevention in general. She believes that it would be possible to utilize such technology much more while including a wider range of stakeholders and increasing governmental demand-side policies. Muni's work confirms authors perception of used technology gap in health domain and helps this thesis to target possible consumer groups better.

Merlin Kolk studied technology-based opportunity recognition capabilities in healthcare companies [7]. Kolk found many suitable case companies to analyze and concluded that most of those companies did not have a systematic process established for opportunity recognition, but companies with a more technical background did act instead proactively emphasizing the importance of contact networks and value of customer validations. For this thesis, Kolk's study gives interesting input from customer validation and technology innovation perspectives.

Evelin Vanker emphasized usability of health services [8]. Vanker found that one of the leading pitfalls in the health domain was the lack of data exchange between health domain actors and she describes the current digitalization in health domains as islands of automation rather than holistic health data exchange - that ends up with multiple services needed for the users of such services. Valuable input into this thesis is the found correlation between basic IT knowledge and satisfaction with digital services. Vanker concluded that better IT knowledge increases the awareness of users, so they know what kind of innovative solutions to ask from their service providers.

3 Research Process and Methodologies

This thesis uses a mixed method approach within applied research methodology. Applied research aims at finding a solution to an existing problem in society [35], and therefore the author chose applied research as the best suitable qualitative method to achieve the set objectives. To best address the objectives and deliver reliable results of the research, the author developed a custom four-step research process, consisting of multiple methodologies.

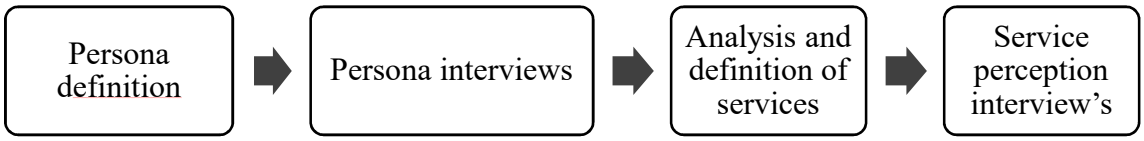

Figure 7. Visual presentation of the research process. Source: Author.

Most applied research that uses science-based design [36] assume the study to be problem driven and solution oriented. In such a study the process focuses on real-world knowledge development to improve the design of practical solutions [37].

Continuous iterations are the underlying principles in Ries's method [29]. Meaning executing short iterations that are defined on top of previous iteration results. As recommended by Ries, short, bi-weekly iterations were chosen. Each iteration starts with defining objectives and tasks for two-week periods, executing those tasks and at the end of the iteration concluding the results that would be then compared to previously set targets. On top of those results, new goals and tasks will be fixed. Tasks outside this two-week period are not addressed by any means during the ongoing iteration. There are usually tasks that on the roadmap would be further away than two weeks - in such cases, the high-level description of the task would be placed into the future backlog, and a more detailed task description would be made when it is time to execute that particular task. When tasks are longer than two weeks, those tasks would be split into parts, and those parts would be separately completed. For a better general overview, the backlog can include tasks and topics out of the scope of this study - to indicate positioning of this study with related topics and future missions that should be considered when conducting

the research. Ries's method was in full extent used in this research even though it is meant to support much bigger and more complex studies.

3.1 Persona definition

For iterating on customers needs, the definition of Personas has to be established in advance as described by Ries [29]. Each Persona has to represent a potential customer group. With detailed information about their interests and needs but also health-related behavior, it is easier later in the process to match the customers and possible services that would fulfill their requirements. Each of them got a name, short description of who they are, what they like, socio-economic description and a brief overview of their relation to health services and technology usage (
Appendix 1 – Sample Persona card).

Those Personas had to be validated on the real market. For that, the author chose in-depth interviews with experts in the health domain. An in-depth interview is the best method to capture more general understanding and personal opinion of interviewees [38]. As broad the interviewees base, as wide the feedback - therefore representatives from hospitals, general practitioners, quantified self movement, but also from political decision making, fitness trainers, and nutrition experts should be involved as interviewees.

Six experts were contacted and agreed to in-depth interviews. One representative for each field mentioned above of expertise was invited. The author listed interviewee candidates by their reputation in their area of expertise and chose then using snowball method [39]. All interviews were conducted by the author in face-to-face meetings and followed similar predefined yet open structure. Guidings were visible only to the interviewer. The gathered answers were marked on the answer sheet on site. Also, more interesting comments were written down on site to record details of wordings.

The first part of expert interviews focused on interviewees field of expertise and (technical) developments in that field. Also usage of technology in the field and interviewees opinion on what was missing in their everyday work. Personas were presented to experts in the second half of those interviews.

For a decent understanding of expert validated Personas, three rounds of interviews with the representatives of such Personas were defined by the author. As a quality control mechanism, short iterations combined with expert knowledge and three separate rounds of customer interviews is a good way to ensure reliable results. Especially when expert

validation is the first to provide the right direction, and then consumer interviews will get more detailed and therefore more statistically relevant.

3.2 Persona interview's

The author wanted to keep the first round of consumer interviews as open as possible. Only some small guiding were predefined for cases where interviewees would drift too far from the authors intended topic. Again in-depth interviews were chosen to best capture personal needs and feelings [40] related to health domain. The downside of in-depth interviews is the subjectiveness of answers and the time it requires per meeting.

Defined guidelines for an interview (Appendix 2 – First round interview worksheet) listed the topics relevant to the thesis. Discussions were based on the printed interview guiding's that were visible only to the interviewer. Interviewees were only guided to go through their Health Behavior, Health Services and Technology Acceptance preferences and multiple-choice options were avoided. For faster and better note taking author chose to code the possible answers beforehand for all guiding questions as described below. Such coding enabled to capture the most direct opinions and emotions on-site in real time.

First, the underlying task was to evaluate people's willingness to put more effort and change today's' health behavior, to improve their health as proposed by the Transtheoretical Model [17]. Whereas five stages were defined as:

1. I will not do anything
2. Only if somebody orders me to
3. I am interested and might start soon
4. Already doing something
5. I am already doing so much

The second question seeks to understand if people value data and if they are willing to gather health-related data. Whereas:

NO Person is not interested or not willing to gather data
YES Person is interested and willing to gather data
APP Already gathering data with one or multiple apps
Auto Only automatic gathering of data. No personal effort for data collection

Sec	Security or privacy concern

The third question addressed the interpretation of health data. Interviewees were guided to discuss what kind of presentations are available to their knowledge and asked about their perception of digitally interpreting and providing the results versus human specialist's opinion. Options in the table are:

Human	Includes Friends, trainers, and medical specialist
Multiple	People would prefer to get multiple evaluations
Self	People only themselves would evaluate their data
Tec	Technological in-APP algorithms were mentioned

The fourth question targeted people's acceptance of a digital communication. In the table, following codings have been done:

f2f	Face-to-face meeting in the same room with expert
Call	Regular voice call over a phone
Skype	Video call in general, could be PC or mobile,
Gadgets	Willing to use technical gadgets to gather data

The fifth question addressed long-term motivation as proposed by Health Belief Model [15] - what are the reasonings why people would or would not put the effort for their health and consumed digital health services. Abbreviations in the table are:

Progress	Interest to track Personal advancing in time
Compare	Comparing one's results with friends and averages
Social	Interest to compare and willingness to share in social networks
PoM	Peace of Mind - I want to be sure everything is fine
Predict	Let me know the future of my current health behavior
Specialist	Somebody else ordered me to focus on my health
Second	Need for the second opinion on my progress or diagnosis

Next topic of research was what type of (digital health) services people would like to consume. For the table the following keywords were defined:

Audit	Any health audit to get to know your current state of health
Guidings	Tell me what to do, how others are doing, I want to reach a goal
PoM	Peace of Mind - Overview + 24/7 screening Analytics on my data

Diary	Any need to log conditions or consumptions
Video	Video call to health expert of desired expertise
Gadgets	Physical devices that gather health data

Interviewees were recruited based on Personas and started from authors personal network and continued by snowball method until all the necessary interviews were conducted [39]. After the first round of interviews, the more precise semi-structured interview was framed and conducted to complement the first round.

3.3 Analysis and definition of services

Field data analysis is the essential part of qualitative research as the author has a lot of freedom to interpret and generalize the answers according to his or her background and preferences. Data analysis strategy for this thesis relied on thematic analysis method [41] that is based on predetermined themes and data is analyzed through a coding scheme.

After the interview, the author digitized the answers using aggregated coding tables for a better overview as presented in the Results chapter. The author coded predetermined themes, yet this coding was flexibly further developed during the process to best maintain the actual feedback and not to limit the given color with authors previously defined coding.

Defining possible new service offerings followed the Ries' Service Design model [29]. At the beginning of the research, the author would describe initial Value Offerings as possible services and then validate those services during interviews. Each round of end-user interviews detailed the service offering further. When there is no need for some of the proposed services, such service will be removed from the research.

Analyzes resulted in highlighting entirely different expectations of what aspects a service has to include. With low consensus in first round feedback, the author decided to set also four service levels for each service:

FREE	Nonpersonalised digital guidance and advice
LOW-PRICE	Manual in-APP data insertion for personalization
MODERATE	Sensors for automatic data collection plus video consultation
PREMIUM	More sensors and a face-to-face meeting with an expert

3.4 Service perception interview's

The second round of consumer interviews was conducted in two parts, similarly to expert meetings. The first half of meetings were covered with semi-structured questions about personal preferences, and a second-half previously defined six possible digital health services were introduced as Value Offering [30]. A semi-structured interview is an excellent method to study a similar set of topics, leaving enough openness for flavoring the interview with personal opinions [38].

Discussions were based on the printed interview guiding's that were visible only to the interviewer (Appendix 3 – Second round interview worksheet). In the first part of interview people had to indicate their interest in sports, prevention, healthcare and medicine domains in general. The second question sought to understand if people had any specific health issue or had set any health improvement goals for themselves. The third question touched the importance of health topics and in the previous question found a reason why he/she is focusing on health.

In the second part, six service offerings (Defined services) were introduced by laying them on the table so the interviewee could read and compare the services as proposed by Osterwalder [30]. Then they had to indicate their first impression and if they would be interested in any of those services. In case of interest, interviewees were allowed to choose up to three services, and after a few minutes studying the difference in the service levels, they had to choose the level they would like to purchase. Next question was about the price - "how much you are willing to pay for this level of service you have in mind?"

4 Results

In this chapter, all the results of the research are presented. After Defining of Personas, validating these personas with expert interviews, followed by two rounds of Customer interviews, enough data was acquired to analyze and address the objectives of the thesis successfully. Results are grouped according to the author-defined four-step research process.

4.1 Persona definition

The first task was to define Personas, who would be interested in health technology or health services. Without limitations at the beginning of the study, 13 initial personas were established following the model proposed by Ries [29].

1. Elderly people with the diagnosed disease
2. Elderly people without a diagnosis
3. Single elderly people
4. Healthy elderly
5. People with chronic diseases
6. Workaholics
7. Mid-Aged men, no diagnosis, no good overview of health
8. Parents of young children
9. Fitness people
10. Hobby sportsmen
11. Youngsters
12. Children
13. Health service consumer from London

Analyzes of the interviews started in parallel with those interviews so the results could be used as an input for next iterations in the research process.

Expert interviews gave good feedback from years of experience in their field of expertise and concluded with six personas. This was a valuable start to study correct consumer groups perceptions for digital health services. Personas were chosen by how open they

potentially would be for innovative technology-based services, how evident are their actual needs connected to health and their willingness to pay for (digital) health services.

Remaining Personas were:

1. Fitness girls (Fitness)
2. Hobby sportsmen (Sports)
3. Parents of young children (Parents)
4. Workaholics
5. Mid-aged men (Mid-aged)
6. Healthy elderly (Elderly)

For a persona description details are essential, and naming of personas includes attributes that later in the text and tables are not relevant as there are fitness people from both sexes for example. For better readability, personas are later in the document referred shorter as indicated in the bracelets above and are distinguished from the rest of the text by a capital letter.

4.2 Persona interview's

For the first round of Persona validation, 18 interviewees were recruited for in-depth interviews, with three persons from every six remaining personas. Interviews were conducted in the most convenient surroundings for the persons - being their home, workplace or a cafeteria.

The primary goal in this round of interviews was to understand if the actual persons chosen to represent a specific Persona, answers similarly to other persons in the same group and also see if there are overlapping interests of those personas.

Table 1. Coded answers of first-round interviews by Persona. Source: author.

	Will for effort	Data gathering	Who should Interpret?	Digital communication	Motivation - why?	What type of Services	Goal
Fitness, 28	3	Auto		Skype, f2f	Progress, Predict, Motivate	Video	time, social, habits
Fitness, 35	3	APP	Multiple	Gadgets, f2f	Progress	Guidings	Personal, free
Fitness, 31	4	APP	Self	f2f	Progress	Audit	PoM, live longer
Sports, 32	5	APP	Multiple	f2f, gadgets	Compare, Progress	PoM, Audit, gadgets, Insurance	Prevent
Sports, 30	3	APP	Human	f2f, gadgets	Compare, Progress	Audit, Video	Big picture, PoM, fun
Sports, 30	3	No		Skype	Progress, Social, Motivate	Guidings	Social
Parent, 30	5	Yes	Multiple	Skype	Progress, Social, Motivate	PoM, Audit, Video, Guidings	Personal, Wholistic, Guiding
Parent, 29	2	No	Human	call, f2f	No	No	Expert when problem
Parent, 33	3	Auto, (sec)	Human	f2f	Second	Video, PoM, Audit	PoM
workaholic, 43	5	No, (sec)	Multiple	Skype, f2f	Predict	PoM, Audit	PoM
Workaholic, 34	2	Auto	Multiple	Skype, f2f	Second	Audit, Video	PoM
Workaholic, 28	4	Auto	Human	Skype	PoM	PoM, Video	Prevent, PoM
Mid-Aged, 44	3	Yes	Human	Skype	Progress, Social	Audit, video	Prevent, quality
Mid-Aged, 49	4	Auto	Human	Skype	Specialist	PoM, Video	Big Picture, Time
Mid-aged, 52	2	Auto	Human	Gadgets, f2f	PoM	Audit, Video, PoM	Insurance, PoM
Elderly, 66	2	if doc	Tec + Human	Gadgets, f2f	Progress, Specialist	Diary, Audit, Guidings, Video	Weight
Elderly, 67	3	No	No	Skype, f2f	No	No	Enjoy, don't worry
Elderly, 64	3	APP	Self + Internet	Skype	Progress	PoM, Insurance	Prevent, time

None of the interviewed persons said they did not care, or that they were not willing to put an effort by themselves. Half (8/18) of the responses indicated an interest, but they still need some push or external motivation to start putting more effort in advancing their health. A third (6/18) of respondents were already consciously improving their health and performance.

Responses to data gathering split quite equally between already collecting data with some application (5/18), not interested in collecting any data (4/18) and accepting if data is gathered automatically and the person does not have to insert anything manually (6/18).

One Elderly(61) indicated an interest in having both technological and human evaluations as he had lived long with his chronic diagnosis and therefore he already knew what to monitor and only in case of deviations he would turn to a specialist. The majority (13/18) responded with a preference for human interpretation of data. Even though they would prefer a human explanation, only two interviewees told they did not trust technological statements at all; all others would be interested in having a technical evaluation run in parallel as well.

When both Skype and f2f are presented, it means combining those two channels dependent on the topic at hand and not preferring neither one as the main channel. If only one is present, clear preference was indicated. Only two respondents said only face-to-face meetings would be acceptable for them, at the same time many (11/18) reported that digital communications would help them to keep track of and improve their health.

Main aspects told in favor of digital channels are saved time and avoided microbes where many infected people are. Against digital communication, some said the quality of face-to-face meeting is better due to the possibility of physical measurements or evaluation right on-site if needed. Also, elderly people would need assistance with digital channels. Two respondents said to “live digitally” anyhow, so video calls today means face-to-face meeting for them and physical presence in the same room is not essential. Only one person said to prefer regular voice call instead of a video call as her main medical contact is familiar enough, and she does not need to see the doctor at the time of a call. Many others said that video picture would enrich the communication and they would not like to discuss their health data over the voice-only call.

The primary motivation (10/18) to start collecting data and improving health was to track persons own progress in time. Also comparing with others and sharing with friends in social media got considerable notion (5/18).

Most notions got (Health) Audit (10/18) as getting a decent overview of one's health current state. Most people told not to have a good understanding of how good or bad they are compared to friends or averages and if they should continue their current health behavior or better to change something.

Also many (10/18) appointed the convenience of video calls instead of going somewhere. This includes people (6/18) who said to prefer Video call instead of face-to-face meetings but also people (4/18) who prefer face-to-face meetings but are accepting the technology as a better/faster option in some cases.

Peace of mind was mentioned many times (8/18). It was described as not something people would consume on a daily basis, preferably as an Alarm service which will let people know if they have to pay attention to or change something in their behavior. Any other time people do not want to worry about if everything is okay or not. It was mostly named together with data collection, but most people did not see value in just collecting and visualizing data separately without using it for further analyses.

Guidings were mentioned multiple times (4/18), mostly with a connection to doing right things for one's health or performing concrete exercises, but one respondent also would like someone to set his goals and guide him there. When most people would be ready to have digital guidance, two interviewees only would accept expert guidings during face-to-face meetings.

One person said being more interested in someone else's health than in her own - it was her grandmother.

The last question was the long-term goal of people - where do they want to be in the future. Again peace of mind was the most common (7/18) answer. Also, prevention (4/18), time-saving (3/18), better insurance (3/18) and personalization (2/18) was mentioned. One Elderly stated that the most critical aspect is to enjoy life and not to worry too much.

4.3 Defined services

Below there are six service offerings in Table 2 – Table 7, that were created and presented to the interviewees in the second round of consumer interviews. For a better understanding of service offering and its' different levels, offerings were defined as 4-by-4 table and are here described as they were presented during the interviews.

Table 2. Health Audit service offering. Source: author.

Health Audit	Free	Low-Price	Moderate	Premium
Self diagnosis in-APP questionnaire	✓	✓	✓	✓
7 days tracking diary (Sleep, heart rate, nutrition)	✗	✓	✓	✓
Tracking sensors (Sleep, heart rate, weight)	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Lab analysis (Blood, urine, spirography)	✗	✗	✗	✓
Expert consultation on top of the measured information	✗	✗	✗	✓

Table 3. Cardio training service offering. Source: author.

Cardio training	Free	Low-Price	Moderate	Premium
Expert writen program to follow	✓	✓	✓	✓
APP of audio/video sample exercises	✗	✓	✓	✓
Tracking sensors (Sleep, heart rate, weight, activity)	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Lab analysis (Performance parameters, spirography)	✗	✗	✗	✓
Expert consultation on top of the measured information	✗	✗	✗	✓

Table 4. Health condition diary service offering. Source: author.

Health condition Diary	Free	Low-Price	Moderate	Premium
Expert writen program to follow	✓	✓	✓	✓
APP for data insertion	✗	✓	✓	✓
Sensors for condition monitoring	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Lab analysis (Blood, urine, spirography)	✗	✗	✗	✓
Expert consultation on top of the monitoring results	✗	✗	✗	✓

Table 5. Peace of mind program service offering. Source: author.

Peace of Mind program	Free	Low-Price	Moderate	Premium
Expert writen guidings to follow	✓	✓	✓	✓
Self diagnosis in-APP questionnaire	✗	✓	✓	✓
APP of audio/video guidings	✗	✓	✓	✓
Special therapy APP	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Expert consultation on top of the monitoring results	✗	✗	✗	✓

Table 6. Better sleep service offering. Source: author.

Program for better sleep	Free	Low-Price	Moderate	Premium
Expert writen program to follow	✓	✓	✓	✓
APP for data insertion in mornings	✗	✓	✓	✓
Sensors for sleep monitoring	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Lab analysis of sleep	✗	✗	✗	✓
Expert consultation on top of the monitoring results	✗	✗	✗	✓

Table 7. Consultation with Expert service offering. Source: author.

Consultation with Expert	Free	Low-Price	Moderate	Premium
Self diagnosis questionnaire in APP by Expert	✓	✓	✓	✓
Technical analysing algorithm by Expert	✗	✓	✓	✓
Web-chat with Expert	✗	✗	✓	✓
Video consultation with Expert	✗	✗	✓	✓
Video consultation with best Expert	✗	✗	✗	✓

Five of six services followed the same structure, offering a health improvement together with technology for monitoring that health domain and Consultation with Expert offering was touching the technology acceptance to use digital channels.

4.4 Service perception and WTP interviews

For the second round of consumer interviews, 15 interviews were conducted with seven men and eight women. Respondents were between 23 and 64 years of age with an average age of 42 years.

Table 8. Service perception by persona and age. Source: author.

Interviewee	Cardio	Peace of mind	Audit	Video consultation	Health condition	Better sleep
Fitness, 23				X		X
Fitness, 32	X		X	X		
Fitness, 36	X		X			
Sports, 30	X		X			
Sports, 36			X	X		
Sports, 36	X	X	X			X
Parent, 36	X					
Parent, 37			X	X		X
Parent, 43				X		
Mid-Age, 42	X		X			
Mid-Age, 42				X	X	
Mid-Age, 45		X	X			X
Elderly, 59	X	X	X			
Elderly, 61		X	X	X		X
Elderly, 64						
Total interest:	7	4	10	7	1	5

Most interviewees stated their interest to know more about healthcare (10/15) and prevention (9/15). Less exciting was to get knowledge about medicine (6/15).

Out of six services that were introduced, the audit was by far the most popular service (10/15). Recommendations for a more active lifestyle in the form of a Cardio planning tool was interesting for half of the respondents (7/15). Consultation with a health professional was also mentioned often (7/15). Five persons were interested in sleep and four persons in the peace of mind guidance. Only one person wanted specific health condition monitoring - all other interviewees said not to have particular conditions to monitor.

Six out of seven people chose video consultation as a preferred digital communication channel. One person chose a free self-diagnose option, and nobody chose the best expert or web-chat nor technical algorithm.

Only one person was not interested in any of the proposed digital services. One Elderly(64) said he would only trust a meeting with his Family Doctor. When his doctor would suggest a technical tool, he would use it.

A Parent (36), also stands out from the chart as she is the only one to request only one service - she commented that all the information is available on the internet and she has made herself a personal plan and followed that. The only exciting application would be specific running app that shows the details of the exercise on a video and later analyzes if the training has been followed correctly. Also, detailed feedback from a high-level specialist would be of interest.

One Mid-aged(42) had an accident and needed rehabilitation. He tried multiple applications but was not satisfied - he was missing an application with guidings for exercises and option to mark if he followed the steerings with a possibility to evaluate how he performed the activity.

For the open-ended question “Why this service,” most interviewees responded “I would like to be sure that everything is under control and I do not have to worry” or similarly. Another, somewhat standard response was that people are tired of looking for information from multiple applications/locations - it would be most convenient to have everything in one place - both medical and wellbeing data.

Out of the proposed four levels of service, only two received actual interest - Free and Medium level of services. For free people would be willing to study services and when they make the purchase decision, a Premium level seemed too fancy, and they would prefer Medium level service.

“When I am interested in a service, then I do not want cheap service, and I do not need premium as this is probably for professional athletes.” a Fitness(36) said.

One of the main reasons told to avoid low-cost service was the need to insert the data manually. In Medium level service already, some sensor was included that automated the data collection process. On top of that data, automatic algorithms would scan for abnormalities and only let people know if there might be a risk for worsening condition or better to give recommendations right away.

“Do not visualize my problem, offer me a solution” one Parent said.

For example, Health Audit got ten persons interested, and out of those ten, two consumers would choose Free service level, and eight would choose the Medium bundle that was seen as best value for the money. Even though no exact price was indicated.

For the question about subjective personal feeling about how much they would pay for the service, the typical result was 20-30€ for one Medium service or 30-40€ for a bundle of 3-4 Medium level services per month, that would be similar to what they pay for internet service as they commented. Some people also would like to have a family bundle. People saw a possible reduction of pension fund payments and life insurance payments as a cover for the new cost in their budget.

Two interviewees mentioned or asked anything about privacy and security topics. The only comments about trust were about trusting the service provider, not a technical solution for gathering data or delivering the service.

5 Discussion

The focus of this thesis is to identify possible added values from technology usage in the health domain. For that, digital health service offerings were brought for evaluation by different possible customer groups or personas as Osterwalder [30] defines them.

In the first round of interviews, two separate groups emerged: Fitness, Sports and Elderly who have a focus on health already and Parents, Workaholics and Mid-Aged who do not put much effort into improving their health yet would like to have technology in the background telling them they are doing well.

All Sports and Fitness respondents (6/6) were strongly motivated to track their progress, and also most Elderly Persona respondents (2/3) said their primary goal was to improve their achievement or conditions. While young fitness and sports people are fine-tuning their peak-performances, elderly people are instead facing diseases and diagnoses - they both have in common the inner motivation to improve their health. This indicates that a person's inner motivation for better health appears to be a crucial factor for taking action and not letting go the responsibility of one's' own health.

Three other personas - Parents, Workaholics, and Mid-Aged mostly (7/9) cared for automated background service, that would automatically collect and process the data and will only let them know when something has to be changed. This suggests that people without current health issues and without performance goals are not interested in daily based information about their health, yet they for sure (7/9) would like to have some service telling them it is okay to do whatever they are doing today. The alarm would be created when the deviation is too big, and some change is recommended. Those personas stood out also with 100% (9/9) of human only interpretation of health data. The author suggests this is due to their low daily interest on their health and therefore little knowledge of actual digital health technology and its capabilities nowadays.

Workaholics were the most statistically valid/significant persona out of six defined personas. They all (3/3) stated that Peace of Mind or knowledge that they can continue as they have until now was most important. Also, all of them (3/3) had strong preference to use digital communication channels instead of going somewhere. Workaholics were also most interested (2/3) in multiple opinions on top of their information as digital data is

accessible to present to experts and through digital channels, it would take a short time to get such opinions.

Even though the majority (11/18) said they prefer face-to-face meetings in the first round, people did not choose premium level service where they would have such meetings included. One reason might be that they felt that it might be somewhat expensive, even though no price was mentioned by the interviewer.

People had surprisingly few (2/18) concerns about their privacy and data security. In the interviews, the service provider was not mentioned, and therefore people could not adequately evaluate those aspects of service, but it hardly got any attention (2/18) during the interviews at all. The author suggests that as all respondents were Estonians and they probably are used to Estonian national electronic health record services, this secure comfort carried over to this research. Those two times security or trust was mentioned it was instead related to service providers trust level, not trust for technical means of providing the service. Such a finding does indicate rather a big gap between the concerns of people interviewed in this research and evaluations of European governments who found security and privacy as the leading barriers to eHealth adoption.

Parents, Workaholics, and Mid-Aged tend to trust human evaluation much more (11/12) than technology. In comments, they emphasized friends' opinions to be much more important than views of experts not known for them. Therefore, engaging technology savvy early adopters as evangelists for digital health services could give the most valuable word-of-mouth recommendation to such services. Active participation of those evangelists' and sharing their stories also work' as an educational and engagement tool for the early and late majority as defined by Rogers' [25].

Among the most exciting aspects of introduced digital health services were named as

- Connecting medical and personal level health information creates extra value
- Better overview and constant monitoring delivers peace of mind
- Prevention is better than fixing
- The personalization of services that comes from using my actual data

Few negative aspects of digital health services that got mentioned were:

- Too much information
- Losing personal touch to technology
- Complexity of services

Health Audit was the most exciting service (10/15) for people. Most of the comments turned around not knowing their current status nor having a real goal for one's health or performance. This leaves an excellent opportunity for services that are positioning people's health compared to other similar people. Digital (health) technology can bring all the knowledge from all around the world under one's fingertips in just seconds and would help to set the framework for everyday health behavior for masses.

In the first round of interviews, many comments were about a wish for the opinion of the best experts. In the second round, out of seven persons who chose consultation with expert no one picked the premium package where "the best expert" was proposed. The author suggests' that people were afraid of the cost. Even when the price was not indicated, interviewees probably figured out a subjective monetary value for that best expert and premium level of service and then chose a more affordable option. This gap between the initial statement of interest and actual buying decision when (even when subjective) there is a monetary aspect attached to the service, is an important finding and should be kept in mind whenever designing a new service. Such a gap also correlates with Lindströms' findings that people state higher levels of service and their actual buying decision might vary extensively [34].

5.1 Limitations

Recruitment followed proportionally predefined personas so each persona of interest would have the same number of representatives. Personas already defined the demographics and socio-economic status that was validated during the interview. Even though a persona did also specify an exact location for living, representatives of such persona in the real world could live anywhere else as well - therefore interviewees were recruited from Tallinn, Tartu, and Toila, to get more representative results. It was hard to get proportionally distributed interviewees all around Estonia. From Toila more representatives were of mid-aged men and women with children, and at the same time,

there were difficulties of locating a hobby sportsman and workaholic by the persona definition. This is a slight limitation for generalizations of the results.

Interviewees were recruited in the first round of interviews from the author's personal contact list. This way it was possible to target people as similar to the defined personas as possible, but it also exposed some bias due to familiar relations between interviewer and interviewees where some information might have been manipulated due to the close ties. For the second-round interviewees were approached through their employer, who got the description of personas and pointed out matching persons, who were allowed to do the interviews during the work time. This way the familiarity bias was eliminated but the selection of interviewees was handed to somebody else, exposing the choice to his/her opinion on the topic.

All the answers gathered during the interviews were given in the Estonian language. The author has translated those answers to his best knowledge and using web-based dictionaries. This might expose the risk of interpretation. This might affect some comments presented in this study. As the research was carried out in one language without intermediate translations, possible translation subjectivity only affects some localized wordings and are not carried over from one step of a process to another and therefore does not affect the process and results as a whole.

From interview notes, later the author defined keywords to conclude the results and made classification and distribution of answers. This exposes an author's subjectivity bias where the author could have interpreted some answers differently than its origin.

All interviewees were given 10€ gift cards after the interviews. They did not accept the conversation with that knowledge so to the authors best experience this did not expose any recruitment bias in interviewees selection nor in their answers as the reward was not dependent on the answers.

Considering that all interviewed experts are opinion leaders in their domains, and they agreed to interview without hesitation openly sharing their support for such a study and such digital services, this might indicate that they all are in that 2,5% of innovators as proposed by Roger’s Diffusion of Innovation theory [25]. And their answers can, therefore, be biased in favor of innovation. As those experts had only to help to choose

the most promising consumer groups or personas to study, this bias would not influence the results of this study.

5.2 Recommendations for future research

Considering the findings of the thesis and Reis's [29] proposed service innovation model, it would make sense to conduct a quantitative follow-up study in the form of a landing page with advanced offerings of the services studied in this research. With actual monetary values appointed and a possibility of signing up for those services, would either confirm or deny the results of this thesis.

Chronic disease monitoring and rehabilitation were mentioned in the interviews. As the thesis did not go into any specific health services, more detailed studies, focusing on actual health service or condition using same or similar research process would add value to this research.

One of the assumptions of the thesis was that there is enough technology (gadgets) arriving at the market and this will not be a limitation for services defined in this research [3], [5]. Considering the high technology acceptance by the interviewees, in-depth study on digital health technologies' availability and affordability would be a valuable input for health services design.

High willingness to pay is one of the positive surprises in the results of the thesis. Eight out of ten interviewees preferred paid service instead of free offering. As author defined offerings included much complexity through involving multiple devices and technologies and persons, the business model of such service would be complex as well. Therefore, everything related to the value chain and business models would be valuable follow up research and addition to this thesis.

Also, this thesis did not cover services nor technology security aspects. Even thus only a few people mentioned security and privacy concerns in this study; it is not correlating with WHO findings, where security and integrations were named number one barrier in adopting eHealth solutions in Europe (Peterson, Hamilton, and Hasvold, 2016). It would be an interesting study to compare why people are so little concerned in the privacy issues and if the perception of privacy is similar to Estonia all over Europe, across the globe.

6 Conclusion

Previous research from WHO suggests the eHealth plays a vital role in expanding the access and engaging the citizens in their own wellbeing [9]. Research in Estonia has discovered potential benefits from the application of digital technologies in the health domain, and furthermore found more systemic approaches to the involvement of technology to improve the speed with which the uptake and customer focus could result in improved usability [6]–[8].

To further complement the previous research, the author sought to add an end-users view to digital health domain. The aim of this research was to understand the perception of digital health services and peoples willingness to pay for such services. The focus of the thesis was on technology acceptance and technology' perceived added value to health-related services.

This research defined possible customer groups and validated those with expert interviews. The second step conducted 18 in-depth interviews with representatives of those groups. The third step included of data analyzes and formulation of six digital health services and final stage was to validate these defined service offerings with 15 end-users.

The author finds the results strongly correlating with expectations, and main findings include' that digital technologies are well accepted, and people are willing to pay for digital health services.

People are ready to use technical gadgets and digital services to improve their health. Thus, only technology-based services were not in favor, and people did not see enough value in data itself. Human contributions to those services are necessary for recommending or approving the technology to use and interpreting the data by an expert in that field, for gaining the trust of end-users.

Majority of people would like to have technology monitoring them in the background for peace of mind. The early-adopters to actively consume digital health services include people of all age, with inner-motivation for improved health. While younger people are driven by performance goals, older people by some (diagnosed) health condition.

Customers also expressed strong willingness to pay for such gadgets and services. This correlates well with wearables shipment statistics which has shown and is predicted to continue an active growth [3], [5].

Both main conclusions, end-users' openness to using digital health services and willingness to pay for such services, are significant findings as input for digital health services development in Estonia.

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Appendix 1 – Sample Persona cards

NOOR LAPSEVANEM (MADIS, 28)

"Tervis on kõik see, kuidas elame ja mida teeme. Nagu hiina vanasõna ütleb, enda haiguse põhjust otsi taldriku põhjast ja stressist. Siis kui on OK, siis hoolitseda."

Elukutse	Tarkvaraarendaja
Pereseis	Vabaabielu
Elukoht	Tallinn, Kadriorg
Haridus	Kõrgharidus
Sissetulek (neto)	1600 €
Telefon	iPhone
Seadmed	Kodus TVd pole
Tasulised rakendused	Jah
Jälgib, mõõdab	Liikumist, Endomondo
Terviseinfo	Foorumid, portaalid, perearsti infoliin, oma perearst
Mida täna tervise heaks teeb	sõidab tööle ning viib lapse lasteaeda jalgrattaga.

KÕBUS EAKAS (MARE, 64)

"Tervis on niisugune valdkond, mille nimel mul pole kahju kulutada /.../ omaosalusega teha kõike, mis on võimalik ja vajalik."

Elukutse	Pensionär (arhitekt)
Pereseis	Abielus
Elukoht	Tallinn, Südalinn
Haridus	Kõrgharidus
Sissetulek (neto)	1100 €
Telefon	Tavamobiil
Seadmed	Sülearvuti, digiTV
Tasulised rakendused	Ei
Jälgib, mõõdab	Vererõhk, võrdleb vereanalüüse
Terviseinfo	Kodutohter, arst.ee, abikaasa.
Mida täna tervise heaks teeb	Liigub jala, (kogub analüüsid kaustikusse), on käinud eraarstide ja alternatiivmeditsiini pakkujate juures.

Appendix 2 – First round interview worksheet

Name _____
Persona _____
Age _____

Introduction and background

Health behavior
- What is health for you
- What are you doing today to improve your health
- Is it enough or you'd like to but some more effort
- What is your long-term goal for health

Health services
- What is a health service for you
- What about Fitness, Gym, Nutrition,
- Are there any health services you are missing today

Technology acceptance
- How much health data you have about yourself
  - National health record
  - APP's
  - Diaries
- How do you understand health information
  - Who evaluates data
  - Technical vs. human interpretation
- Communication channel
  - Face-to-face meetings
  - e-mail
  - Audio call
  - Video call

Appendix 3 – Second round interview worksheet

Name _____
Persona _____
Age _____

Are you interested in ☐ sports ☐ prevention ☐ Healthcare ☐ medicine

Problem. Why this service, why this level of service?
.....

Importance (How big is the problem)
.....

Which of those services would you be interested in:

☐ cardio training ☐ Health audit
☐ Peace of mind ☐ Health condition monitoring
☐ Better sleep ☐ Video consultation with an expert

Please evaluate what is important for you in selected service:

☐ Nonpersonalised digital guidance and advice
☐ Manual in-APP data insertion for personalisation
☐ Sensors for automatic data collection plus video consultation
☐ More sensors and a face-to-face meeting with an expert

“How much are you willing to pay for this level of service you have in mind?”

Appendix 4 – Authors personal position and experience

I have worked with technology innovation for 15 years. Therefore it is safe to say I am a technology savvy person with above average knowledge on technology and digital services. But it also makes me rather demanding customer to any such gadgets and services.

I have had an experience with those applications in previous few years:

SportsTracker	Hundreds of trainings from past seven years
Endomondo	Hundreds of trainings for two years, before SportsTracker
Fitbit	Digital weight and body analyzer for five years.
Fitbit	Activity monitor for two years
Beddit	Sleep tracking for two years
Withings health	Activity monitor for four years
Withings health	Sleep tracking for two years
Polar	Sports watch + swimming watch
MyFitnessPal	Food diary I used few times for few months
Erik Orgu	Food plans, a shopping list for nutrition
Nike+ (on Xbox)	Video training at home

Most of those applications gather data, have some basic comparison function and some have basic recommendations.

Most of these gadgets and applications have been rather a technical exploration than problem-solving, but I have also used that data to improve my sleep or monitor my advancements while preparing for Triathlon.

During this research, I had a privilege to meet many health experts from medical, fitness, nutrition and other domains. I must admit I really value those personal face-to-face meetings more than working only with digital services. Thus, those digital tools reduce the need for those meetings and make the meeting so much more objective and therefore also more productive. My preparation for Triathlon over eight months, for example, included few gadgets, few applications and a trainer who had access to my data. He got notifications after each of my training and commented all such trainings inside those applications. We only met three times, but he knew everything about my nutrition and training and every once in a while he corrected my training plan according to actual results. My results for that triathlons were better than expected. :-)