jamk.fi

Future Foresight into Application of AI Technologies in the Finnish Healthcare

Outlining prospective trends of development in primary care by 2030

Kirill Anton

Bachelor's thesis
May 2020
School of Business/Technology Business and Future Foresight
Degree Programme in International Business

Jyväskylän ammattikorkeakoulu
JAMK University of Applied Sciences

jamk.fi

Description

Author	Type of publication	Date
Anton, Kirill	Bachelor's thesis	May 2020
		Language of publication: English
	Number of pages 152	Permission for web publication: x

Title of publication

Future Foresight into Application of AI Technologies in the Finnish Healthcare

Outlining prospective trends of development in primary care by 2030

Degree programme

Degree Programme in International Business

Supervisor(s)

Saukkonen, Juha

Assigned by

JAMK Centre for Competitiveness

Description

Artificial Intelligence technologies are seen as one of the key drivers of future business development and there are a lot of hopes and expectations surrounding their potential application in various industries. Healthcare industry is regarded as one where AI can achieve its most potential, specifically, in preventive healthcare. This study was focused on investigating the prospective trends of development of AI technologies in the Finnish primary care by 2030.

To accomplish the set research goal, the futures foresight techniques were applied in the course of the study to discern potential futures. The research was based on the inductive reasoning and qualitative primary data was collected through 13 in-depth semi-structured interviews with the professionals from the healthcare and IT sector. Multiple Perspectives and Scenario Planning were utilized as methods of futures research.

The research findings are reflected in three Future Radars and a supporting scenario framework. Future Radars illustrate expectations of interviewees on the topic of the research in the form of associated consequences presented across three perspectives: technological, organizational, and personal. The study identified three major trends for the development of artificial intelligence technologies: integration of AI in the pre-diagnostic stage; in the process of administering diagnostics; and in the post-diagnostic stage. In each of those stages, AI can bring significant benefits to the end consumer, albeit not without major challenges that need to be resolved before the technology is adopted in the Finnish market of primary care. Implications for all stakeholders present in the industry have been considered in the analysis of the research findings. A theoretical framework for the future life cycle of AI technologies in primary care has also been proposed within the research.

Keywords/tags (subjects)

Artificial Intelligence, Healthcare, Primary Health Care, Futures Research, Scenarios

Miscellaneous

Contents

Figures

Tables

1 Introduction

1.1 Background

Modern industries are on the brink of disruption, fostered by a multitude of factors: the latest technologies reshape traditional business practices on an annual basis; the amount of newly designed innovations is pressuring firms to be more technologically intensive; advances in Web, cloud and other software-type services are opening up access to yet untapped business potential (Skilton & Hovsepian 2018). All of the above-mentioned factors form a volatile environment which challenges companies to adapt. Some enterprises advance and achieve a stable margin in the newly formed market through scrutiny and profound change management. Nevertheless, a large proportion of other market players lack the ability to anticipate future technological changes and miss the opportunity to develop sufficient skills to withstand the emerging disruptive force. Major global corporations, consulting firms, acknowledged media and influencers come together on the assumption that artificial intelligence is one of the most disruptive technologies to impact industries worldwide. Although John McCarthy coined Artificial Intelligence as the term after the Dartmouth Conference in 1956, the studies of previous years did not focus primarily on the implementation of AI from a business-wise perspective until the early 21st century. The new milestone for AI research has been fostered by investments coming from private and public funds that continue this technology's development to this day.

The investors probe different industries for potential benefits emerging from the application of AI technologies. Even though the disruptive technological capabilities of AI are thought to be applicable almost everywhere, no other industry can quite compare to the perceived value that AI can bring to the healthcare sector (Artificial Intelligence: Healthcare’s new nervous system 2018). Taking into the account the challenges that healthcare systems worldwide are currently experiencing, such as continuous increases in operating costs, ageing of the population, inequality of access to the provision of medical services (Koller & Khullar 2017), the demand for

new innovative solutions that could curb these trends is unprecedented. Medical professionals and experts from the industry turn to the new and emerging technologies that could potentially provide that vital momentum necessary to sustain the health condition of the population on a decent level. And AI suite of technologies could be just the one that will pave the way for the healthcare systems worldwide to transition to the new age of medical operations and care provision.

Nevertheless, not every business, corporation or state is ready to take on the AI initiative. Finland, on the other hand, stays ahead of the curve by being one of the forerunners of AI development in the European Union and sanctions variety of projects to foster AI integration in the country (Artificial Intelligence Programme 2017). Both public and private companies work together with research foundations to identify the key potential for the application of technology in the country. Finnish Healthcare industry is playing an active role in these cooperation and development initiatives with cases of AI application already being seen in several medical units across the country as part of the trial projects.

Given the acute current relevance of this topic, this study aims to investigate prospective directions for the development of artificial intelligence technology with a focus on Finland's system of primary health care.

1.2 The motivation for the research

In this study, the field of primary (preventive) healthcare industry of Finland was selected as the focal point of the AI investigation for several reasons. First of all, the area of primary health care is considered the one that is oftentimes lagging when it comes to the provision of new technologies, with most of the innovations going into the actual treatments, while prevention methods are somewhat undermined. There is a business as well as a moral concern on why the investments in healthcare are proportioned in such a way and in recent times more prolific action is taken to counter this disbalance. The area of preventive (primary) health care lacks sufficient investment in comparison with the secondary (operational) and tertiary (post)

stages. Such technological advances as AI solutions are thought to bring new value to preventive health care by improving disease prevention practices, thereby reducing the need for 2nd and 3rd stage consecutive care (Koller & Khullar 2017).

The Finnish healthcare system is one of the most recognized in the world for its quality and satisfaction ratings, making it one of the top 30 countries with the best healthcare systems in the world. However, at the same time according to the OECD and World Health Organization report on the country's "Health Profile", primary care provision in the country does not match the same levels of quality and access as the provision of secondary. Suggestions for improvement include digitalization of medical services, integration of new technologies, distribution of authority for conducting clinical operations across the state. (Finland. Country Health Profile 2017.) This argument signifies the need for additional research in the field to investigate potential means to realize the suggested recommendations.

From the technological perspective of the issue, artificial intelligence is seen as the most disruptive healthcare technology according to global industry executives (Artificial Intelligence. The next digital frontier? 2017). It is justified by the fact that the majority of AI-related investments are attributed to the healthcare industry with annual growth rates of approximately 40%, estimated to reach $6.6 billion by 2021 (Artificial Intelligence: Healthcare's new nervous system 2018). Possibilities of application of AI technologies in the primary care are not yet studied in detail which means that there are possibilities to develop new theory within this study which can aid future social actors to act on those projected investments.

As of the European Council in Brussels, 2017, Finland is one of the precursors of AI development in the European Union. On the governmental level, investments, integration, studies and research associated with AI are initiated (Artificial Intelligence Programme 2017). Significant foreign investment from global corporations (e.g. IBM) flows into Finnish Artificial Intelligence Foundations (Neittaanmäki 2017). This creates favourable conditions for the industry stakeholders to take part in projecting potential future scenarios on how the AI disruption will be

used for the society's benefit. The researcher intends to take part in this continuing discussion through proactive interactions with healthcare experts and professionals.

Judging by the challenges outlined above and by the fact that primary care serves as the first point of access for any patient seeking treatment, it becomes a part of the researcher's personal agenda to recognize potential means of improvement and development for the studied subject. The author aims to identify the most prominent directions for implementing AI-based solutions in preventive health care operations in Finland through futures research. The core motivation of the thesis is to administer the study which will be able to produce a practical benefit to the field of primary health care by generating results that could inform the strategic decision-making of the stakeholders present in the industry.

1.3 Research question and approach

Based on the preliminary research conducted on the topic of AI integration in the Finnish primary care and its existing applications at the moment of administering the study, the main research question for the study was formulated as follows:

What are the most prominent directions for the development of AI-based solutions in Finnish primary care?

The following research objectives were developed to determine the framework for the investigation:

- To ascertain the projected directions of development of AI-based solutions.
- To evaluate potential benefits, concerns and challenges arising from AI integration.
- To identify the key factors that would influence the development of AI technologies in Finnish primary care.

The research is administered through a qualitative approach to gather in-depth insights on the topic that are essential to answering the stated research question.

The chosen futures research framework, including the construction of scenarios and conducting analysis through multiple perspectives technique, upholds the qualitative nature of this study. The primary data for the study is collected through a series of in-depth semi-structured interviews with healthcare industry representatives. The research sample of this study is representative of multiple groups of stakeholders present in the industry which provides the researcher with a broad array of perspectives to analyse in an attempt to find any overarching patterns or trends. The author of the study employs several techniques of data analysis and futures research to guide the process of results generation. Constant comparative analysis and multiple perspectives techniques are used to codify the interviewees' statements into meaningful pieces of information which are further evaluated through the tools of future foresight administered in this study, Future Radars and scenarios. The dataset of the research undergoes through constant analysis iterations with every consecutive interview being conducted and transcribed. The author of this study employs several validation strategies to monitor the quality of the processes of data collection and data analysis, thus allowing to make necessary amendments and adjustments while the research unfolds.

The thesis aims at developing a new theory through the application of inductive reasoning. The philosophy of critical realism guides the researcher's judgements in the process of formulation of potential futures, consequently providing the groundwork for several scenarios of the future to emerge during this study. The wider description and justification of the research approach is described in the Methodology chapter of this paper.

1.4 Structure of the thesis

The introductory chapter at the beginning of the thesis describes the context of the study, its main goals in the form of research question and objectives as well as shares the main motivations behind the research process. Then, the readers are introduced to the theoretical background of the research examining topics of Finnish Healthcare, Artificial Intelligence, and Futures studies. Each of these research areas is described

in detail and respective classifications and typologies are presented in the literature review section. Followed by the representation of academic literature, the chapter "Methodology" describes the research design and the research process, including the research approach, methods and techniques of data collection and analysis. This section also covers the aspects of the research validity, reliability and ethics. "Results" chapter is used to showcase the research findings and their analysis and interpretation from the researcher. The readers can find a detailed description of the Future Radars across three perspectives in the "Results" section. The following chapter "Discussion" compares generated research findings with other scientific research and describes practical implications of the results. Finally, the thesis is finished with a summary of the limitations of the study and recommendations for future research in the same section.

2 Literature Review

2.1 Finnish healthcare system

Healthcare industry is the major component of any country, and in most developed countries it accounts for between 8 and 15 per cent of the economy (Walshe and Smith 2011) and is commonly larger than education, agriculture, IT, tourism and telecommunications, making it one of the largest industries in any developed economy (Walshe and Smith 2011). Besides being a sector that has coordinated professional service for the vital purpose of maintaining a country's health-related environment by treating and preventing physical and mental impartments (Griffin et al. 2016). Healthcare is the world's largest employer (Shelby, 2017). According to Statistics Finland (2018), healthcare is Finland's largest employer with 16.32 per cent, followed by Engineering (14.34 per cent), Medical Science, Technical and Administrative Services (11.44 per cent) and Wholesale/Retail Trade (11.40 per cent). This data illustrates the importance of profound research in the pattern of change in the health sector, along with the fact that a large population of the economy's annual budgets goes into health and health-related sectors. While the nature of an

industry's function defines its distinctive characteristics, it is well understood that businesses or organizations are the inventions of the environment and context in which they work, and that is why they are distinctly different despite the common purpose and goal of each national health industry (Walshe and Smith 2011). The pollical attitudes, religious beliefs, economic powers, demographics and community influence health industry across national boundaries (Walshe and Smith 2011). Therefore, healthcare systems vary considerably by country; this includes how each is funded, who is financially responsible, who is covered, what services are provided.

2.1.1 Structure of the Finnish healthcare system

Finland 's healthcare system is largely funded by the government, offering high quality and comprehensive range of health services. In Finland, there are 310 municipalities solely responsible for providing and funding most of their citizens' health care needs (The World’s Most Efficient Healthcare System 2018). Regional hospitals provide specialist care. There are 18 regions, each composed of different municipalities. The members of the councils own and manage the community hospitals. While the municipalities and regions manage health services individually, the national government provides general health policies through the Ministry of Social Affairs and Health. The Ministry regulates and controls the healthcare system at the national level, with responsibility for strategy and goals creation, regulation, monitoring and implementation of changes by various agencies (Teperi et al. 2009). Apart from Finland 's municipal/regional healthcare system, there is also the federal national health insurance (NHI). The NHI provides more comprehensive coverage of health services than the municipal health system, including payment of the expenses of ambulatory medications, transportation costs to health centres, funding for private hospitals' care costs, maternity leave payments and paternity leave allowances, and availability of support and services for mental health recovery (ibid). Under the 1979 Workplace Health Care Act, it is mandatory for employees to provide and fund the workplace health care services to all their workers. It entails providing the health services needed for all health issues and illnesses related to the work. Finally, the private insurance scheme, that is health coverage or delivery system, is

quite recent and not very widespread in Finland because, for example, it is optional with very limited scope and is not applicable to the elderly people.

Finnish healthcare is now one of the best systems among OECD countries and even the world at large, with several national health initiatives focused on disease prevention and the advancement of health standards for all people irrespective of their social standing (The World's Most Efficient Healthcare System 2018). The Finnish constitution guarantees adequate social, health and medical services for every citizen. The achievement, which is the product of a series of combined initiations and enhancements, is responsively focused on the changes in each metric required to achieve a world-class health system (Teperi et al. 2009).

Structurally, Finland 's healthcare delivery is organized via two-parallel systems. The method of two-service delivery is not mutually exclusive but rather complements one another, but sometimes overlaps. Both paths are categorically public and private health care services (Health care in Finland 2013; Teperi et al. 2009). Occupational health care may be listed as the third system because its financing is regulated by separate legislation. Nonetheless, it can not be classified as a third-party delivery network as the care is usually delivered by either public or private providers (Teperi et al. 2009).

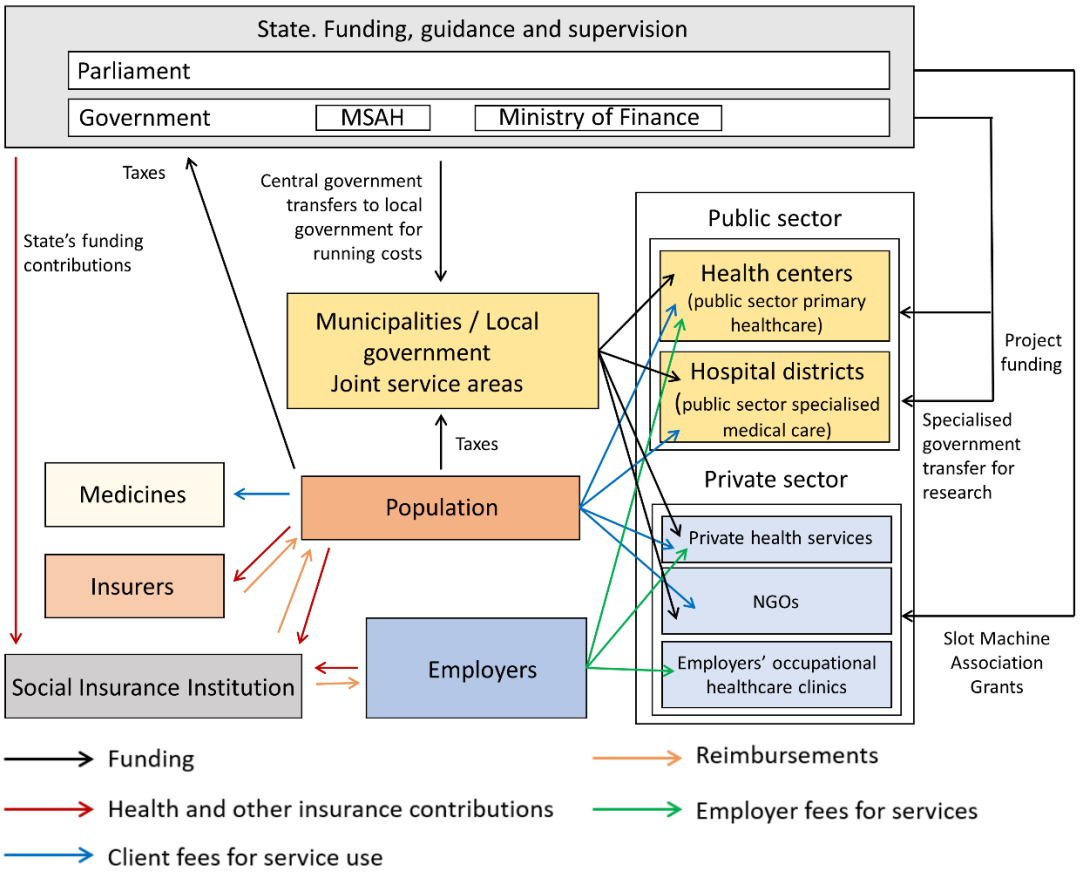


Figure 1. An overview of the Finnish healthcare system (Adapted from Health care in Finland 2013)

The graph presented above showcases the organisation, funding, administration, and supervision of healthcare services in Finland.

2.1.2 Municipal subsystem

Public health care includes the three levels of health care (i.e. primary, specialized, and long-term treatments), but in a different scope. Primary health care, specialized medical care needs and social welfare criteria are managed by municipal authorities as defined by law for each resident (Taperi et al. 2009). Municipal authorities, however, determine whether to provide these services to their residents, which is why the way these services are delivered vary across municipalities.

Coverage is supported by local tax revenue, particularly in primary health care, while advanced care is usually provided by federal government support in most cases. The

amount paid to support municipalities by the central government relies, among many other things, on certain factors such as population and population structure, morbidity (Health care in Finland 2013).

Municipal health care includes health care education, medical care and rehabilitation care, community health services, mental health and substance abuse care, and finally occupational health services. These services, however, are generally divided into three main categories of cares such as primary health care (i) advanced health care and (ii) long - term health care (iii), depending on the category of treatment the local municipal or consolidated municipal (regional) healthcare units may provide. (Taperi et al. 2009)

2.1.3 Private subsystem

The private healthcare system provides services that complement but are primarily in conjunction with public health services. In Finland, private providers include corporations, non-governmental organizations and private health associations that can sell their services directly to individuals as well as state and joint municipal authorities.

Private care mainly provides industrial and primary health care. Finland's 21st - century healthcare services have seen an explosion of private providers, particularly with the recent sector reform. In the moment of writing this study just over one-fourth of social welfare and healthcare services are delivered by healthcare companies and non-governmental organizations either as government outsourced services or directly to clients (Teperi et al. 2009). Nonetheless, the facilities provided by private companies are still very limited and restricted, the most common private services are dental care, physiotherapy, doctor's surgery and mostly occupational health care (Health care in Finland 2013), while the large percentage of private healthcare providers operate mostly in the larger cities across the country and also in the southern part.

2.1.4 Occupational subsystem

The occupational healthcare system is Finland's third-largest access to the healthcare system. The 1979 Occupational Health Act stipulates and obliges all companies to provide workplace healthcare services for all their employees, the act explicitly makes it compulsory for all employers to provide healthcare services to cater for all dangers associated with the work. The care services include first aid services and on-the-job physical exams for employees, plus mandatory annual health status checks for all personnel whose working conditions are classified as hazardous.

Most employers in Finland provide their occupational health services through the local healthcare system, but some also outsource to private healthcare providers (Health care in Finland 2013; Teperi et al. 2009). Interestingly, despite the fact that there are a distinctly different legislative framework and separate funding mechanism for occupational health care, it is legally within the umbrella of primary health care, and that is why employers can demand compensation for the costs of providing their staff with occupational health care.

2.1.5 Shareholders of the Finnish healthcare system

Public health care varies significantly across the globe, and as mentioned earlier, the system and regulation are among the variables that explained these disparities (Walshe and Smith 2011). One such important factor is the stakeholders, the bodies that make up the stakeholders, and the relationships with policies that govern their activities play a pivotal role that defines every system's modus operandi and efficiency. Healthcare stakeholders are individuals or groups of people involved in the provision, financing, regulation, policymaking etc. of healthcare. There are seven categories of these, with different players in each group (Griffin et al. 2016; Walshe and Smith 2011). In Finland, the stakeholders are grouped into the following categories:

1. Customers. Consumers are the primary stakeholders as their knowledge, procurement and use of healthcare most often determine the life of industry.

Consumers in healthcare are the same as other consumers in the service industry; therefore, they expect the same level, even better engagement through the channels they prefer, and healthcare services tailored to their individual needs (Walshe and Smith 2011). In a broader sense, patient advocacy organizations are not limited to patients and their families, but also providers (Griffin et al. 2016).

2. Physicians. These include doctors and other professional associates. They are at the heart of medical decision making as a group of people. They are mostly interested in the generation and the study of medical data which dictates the patients' clinical outcomes and consistency of treatments. Thus, to make good diagnostic or treatment choices, they require a well-grounded and robust source of reliable data.

3. Healthcare institutions. Healthcare institutions and their associations include health and medical institutions, such as hospital systems and medical centres. These are mostly, set up by the governments in many countries, and many of the decisions taken by these bodies are based on specific and regional health and economic issues. These are crucial to the successful functioning of any country's healthcare system and most decisions at this institutional level decide the health outcomes of any population.

4. Buyers and Payers. These are the payers for the costs of the procured health care service. Via insurance policies they can be public, private and even the employers. This group of actors plays a significant role in patient choices and decisions about medications and diagnostics. They determine when, how much to pay and what kind of treatment to take based on a lot of variables.

5. Healthcare companies/manufactures. Drug and device manufacturers are another major stakeholder, depending on many considerations to determine what facility to provide and what research and development to conduct.

6. Policymakers. Health care policymakers are largely government regulatory institutions that are usually operating at various levels such as federal, state, and local. At all levels, politicians make healthcare policies based on their best result and circumstance possible to achieve the most achievable positive health outcome. They work to monitor the operation of all stakeholders in the sector in order to provide quality care, patient-centred and rewarding treatment without violating patients' basic rights.

7. Institutions and experts in the health/medical research field. This stakeholder group influences the decisions of other groups through conducting audits and research of the healthcare operations within the country. They also play an active role in the international agenda of the state's healthcare sector.

This classification of stakeholders in the healthcare industry is not universal and the suggested list of involved parties in the healthcare provision is neither alleged nor final. For the duration of the study, the author referred to the categorization presented above and to the one proposed by the European Connected Health Alliance (Echalliance Ecosystems 2018) which also distinguishes the role of investors and third-sector organizations.

2.2 Introduction to Artificial Intelligence

AI is a broad term which refers to advances that make computers "intelligent." Historically, the use of cognitive tools for performing duties involving human intelligence is widely referred to as AI. Artificial intelligence as a scientific discipline emerged in the late 1990s and it has been steadily advancing since then due to the rise of digitalization and decreasing prices on computer software and programming. The latest and the most advanced AI technologies, for example, IBM's Watson project, demonstrate a pattern of data analyzing similar to human intellect and are able to comprehend an extensive range of a different group of variables at the same time. The "Big Data" phenomenon demands implementation of such technologies to analyse, filter and sort extensive amounts of information while at the same time it

increases the integrative potential of AI allowing businesses to create new offerings or to design new features into existing ones through analysing customers' data.

There are numerous different concepts related to AI, such as deep learning, machine learning (ML), image recognition, natural language processing (NLP), cognitive computing, cognitive enhancement and others. The aim of the AI is to develop a smart, autonomous system. Machine learning is a subset of AI that allows the computer to automatically learn and improve its understanding without explicit programming. AI uses two methods, one is based on symbols and the other is based on data. For the database side called ML, before it can administer the numerical or logical computations, it needs to be fed a lot of relevant data. Technology can look at large amounts of data from high dimensions and determine patterns. Once these calculations have been tested, they can create forecasts with the level of detail unattainable for human administration. (Takyar 2018.)

AI processings' goal includes reasoning, representation of knowledge, planning, learning, NLP, comprehension and the ability to locate, transfer and operate it. The approaches of AI operations include statistic methods, machine intelligence, traditional symbolic AI, search optimization, artificial neural networks. AI's field is based on information technology, math, linguistics, psychology, philosophy and many other areas. Scholars in the fields of statistics and computation have developed advanced techniques for gaining insights from large, diverse data sets. Data can be categorized into different types, and data could be structured or unstructured. Through these techniques, the ability of machines to accomplish tasks, such as NLP and image recognition, can be leveraged through experiential learning. AI software is being developed for a wide range of different industries and sectors (Artificial Intelligence and Machine Learning in Financial Services 2017). In the healthcare sector, AI is studied and used in clinics for performing procedures for dosing drugs and miscellaneous other treatments. Furthermore, AI is used to classify and mark banking and finance events, such as suspicious use of debit cards and large account withdrawals, all of which support the fraud unit of a bank. AI applications are also used for the simplification and facilitation of trading. This is achieved by facilitating

the estimation of inventories' production, demand, and price. (Artificial Intelligence 2018.)

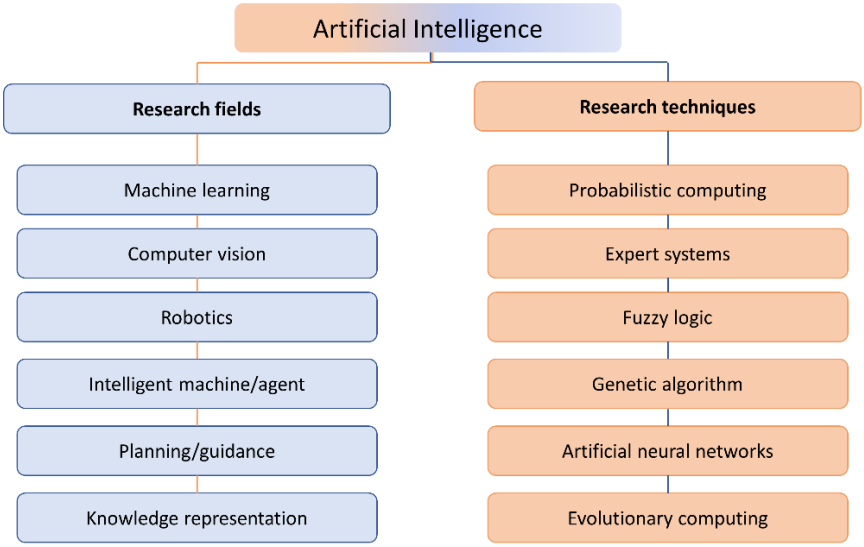


Figure 2. The related techniques and research fields of AI (Adapted from Sidda, Kiranmayi, & Nagaraju 2017, 56)

AI encompasses a variety of research fields and techniques and there are several possible classifications of AI which will be explored in the following section.

2.2.1 Types of Artificial Intelligence

Given the fact that AI is undeniably multifaceted, there are specific types of AI which come under expanded categories. AI includes several terms and definitions that make it difficult to understand the distinction between types, subsets, or variations of AI and each of them is different ideas. Some AI subsets include ML, Big data, and NLP. One of the possible categorizations (Hintze 2016) proposes a division of AI technologies into four main types: reactive machines, restricted memory, mind theory, and self-awareness.

- Reactive computers are types of AI that do not retain “memories” or use past encounters to focus on future activities. They look at the world through observations and respond to them. IBM's Deep Blue, which won against chess

grandmaster Kasparov, is a reactive machine which sees and responds to the pawns on a chessboard. It can not refer to any of its previous experiences, and can not improve with preparation. Another example of reactive computing is Google AlphaGo which won against human Go champion. (Ray 2018.)

- Restricted memory consists of ML designs which derive understanding from already learned information, stored data or events. In comparison to reactive machines, restricted memory learns from the past for looking at activities or information given to it in order to create an experience. Limited memory computers will keep the information for a short period of time. Limited Memory infrastructure is used by many cars, chatbots, and wireless private assistants. (Reynoso 2019.)

- Mind theory AI has the capacity to understand the thoughts and emotions influencing human behaviour. This form of AI should understand emotions, motivations, goals, desires and can be socially interactive. Sophia is a humanoid AI-powered bot which Hanson Robotics invented (Yaninen 2017).

- A self-conscious computer can make representations of itself. They are conscious of their inner states, can anticipate other people's emotions and can create abstractions and inferences. They are the new computer generation: super smart, emotional and alert. The question of whether a machine can really be self-conscious or "thoughtful" is better for philosophers to leave. (ibid.)

Artificial Intelligence technologies can also be classified based on their levels of computational capabilities according to Vernor Vinge's studies on technological advancements (1993):

- Artificial Narrow Intelligence (ANI) also known as Weak AI. This AI Technology category is specialized in one area or specific task. It is relatively limited in scope with intelligence limited to a given area. ANIs are widely used to carry

out iterative analytical tasks such as recognition of text, speech analysis, sorting of records, certain financial operations and more.

- Artificial General Intelligence (AGI) also referred to as Strong AI or Human-Level AI. Computer programming showing "smart" human-level skills across a range of intellectual tasks. Such an AI, in theory, can achieve almost any intellectual task a human being can perform. Intelligence is defined by Professor Linda Gottfredson as "a general mental capacity involving the ability to reason, plan, solve problems, think abstractly, understand complex ideas and learn from experience" (Gottfredson 1997). By covering more than one area for research, Artificial General Intelligence is able to demonstrate such mental capability. A few created AGIs are used for bio-research, content generation, scientific research.

- Artificial Superintelligence (ASI). This AI is defined by its overarching reasoning and analysis capabilities as compared to the human brain. It excels across the board in social abilities, general wisdom and scientific creativity and the multitude of other perceived tasks. ASI is Artificial Intelligence's most advanced form which is not yet clearly defined and stipulated due to its large controversy arising from the strong public resonance. No applications of ASI have been noted or developed at the present moment.

This study looks at the potential application of Artificial Intelligence technologies in the future in all its possible forms and types, thus, a combination of different theoretical frameworks is adopted by the researcher.

2.2.2 Evolution of Artificial Intelligence

The First Industrial Revolution utilized water and steam capacity to automate production. The Second utilized electric capacity to make large scale manufacturing. The Third utilized electronics and data innovation to computerize generation. Presently a Fourth Industrial Revolution is expanding on the third, the computerized revolution that was happening from the middle of the last century. It is portrayed by

a combination of advancements that blurs the borderlines between the physical, computerized, and biological domains. (Schwab 2016.) The present revolutionary age is rooted in intense automation and connectivity worldwide which requires AI. (Jenner 2017.)

AI is certainly not an innovation of the modern time; its narrating roots go far back to Greek artefacts. But it was not exactly a century ago that the technological revolution began, and AI went from fiction to entirely conceivable reality. Alan Turing, mathematician and WWII code-breaker, is generally credited as being one of the main individuals to spring up machines that “think” in 1950. He invented the Turing test, which is used today, as a guideline to decide the machine's capability to "think" as a human. Even though his thoughts were disparaged at that time, they set the wheels in movement, and the expression "AI" became popular in the mid-1950s after Turing died. (Shani 2018.) Alan Turing proposed that if people utilize data and reason to resolve issues and make choices, why can computers not do the same? Despite the fact that Turing described machines and how to test their knowledge in his paper Computing Machinery and Intelligence in 1950, his discoveries did not progress.

The fundamental problem in development was the issue of PCs. Before any further development could occur, machines had to learn how to save computational results, not just be able to perform them. AI was in its volatile stage of development in the early 1970s. Millions were invested, with little to no viable result. The industry's funding has been reduced, leading to the so-called “AI winter”. Financing was likewise an issue up until 1974. After 1974 market of PCs thrived; they were presently quicker, inexpensive and ready to store more data. During the 1980s, AI study backs up with an extension of funds and algorithmic instruments. John Hopfield and David Rumelhart promoted "deep learning" systems which enabled PCs to acquire knowledge from experience. Then again, Edward Feigenbaum presented master frameworks that mirrored the basic leadership procedures of a human expert. It was not until the 2000's that many of the milestone objectives were accomplished, and AI flourished despite the lack of public support and recognition. (Aguis 2019.)

As the Fourth Industrial Revolution emerged in the 21st century, so did the approach of AI. Around 2,000 new businesses worldwide now have AI as a centrepiece of their plan of action. The basis has been laid to move forward with headline-grabbing news like Google's AlphaGo overcoming the Go world champion or Baidu's personal assistant Duer receiving orders at KFC restaurants in China. (AI's transcendence 2018.) In the present day, AI study is continuous and keeps on developing. China is expected to become the largest worldwide source of AI in the next four years, assuming control over the United States' second lead in 2004 and it is rapidly surrounding Europe's main spot. Europe is the biggest and most varied region in terms of global cooperation in AI studies. India is the third biggest in the field of AI research after China and the United States. AI is so essential and developed that a Japanese Venture Capital company has gained its reputation by being the first company to appoint an AI board member to forecast market trends quicker than humans. (Aguis 2019.)

The Fourth Industrial Revolution "describes the changes to the way we live, go to work and relate to each other due to the implementation of online cyber-physical systems, such as the Internet of Things. A couple of predictions put forward by Skilton and Hovsepian include; in the near future individuals can identify and design personalized products and facilities they demand from transport, banking, investment, insurance and other industries (2018). Technology will probably be implemented across all governmental organizations and legal systems with just the most complicated cases involving a human judge and complete trial cases (ibid). Autonomous vehicles will begin showing up in numerous urban areas over the world. (Aguis 2019.) It took a few decades for individuals to perceive the genuine power of AI. High profile investors and physicists, as Elon Musk, founder of electric car manufacturing company Tesla, and Stephen Hawking, a renowned cosmologist, have contributed to the discussion about the potential for AI innovation. While the controversy around AI application goes to potential doomsday situations, there is an agreement that when utilized to benefit people, the technology could fundamentally change the course of humankind history. Furthermore, that is particularly true concerning big data. (Shani 2018.)

2.2.3 Artificial Intelligence in Finland

A steering AI project, whose core mission is to deliberate on the future of AI in Finland, was appointed on the 18th of May 2017 by Economic Affairs Minister Mika Lintilä. The Supervisory Project should: (1) plan a short action program on what the Government can do immediately to make Finland a world leader in AI use; (2) develop a long - term program of action to modernize the world of work, education, research and data economy in general. This group, led by Pekka Ala-Pietilä, published its first interim report on 23 October 2017 (Suomen tekoälyaika [Finland's age of Artificial Intelligence] 2017) and a second interim report on June 2018 (Tekoälyajan työ [Work in the Age of Artificial Intelligence] 2018). Finland 's Age of Artificial Intelligence report (2017) abstract concluded: "Finland has excellent opportunities to be among the winners in this transformation – when calculating the impact of artificial intelligence on economic growth Finland ranked second among 11 developed countries. The pervasive use and application of artificial intelligence provide a vision of the future for a stable and healthy Finland".

The tasks assigned to the steering group were:

- How can the public and private sectors collaborate best to ensure that companies receive adequate support to produce technologies based on AI?

- How can data-driven companies benefit from the indirect use of information resources from the public sector?

- How will AI affect us as individuals and what impact will it have on the future of our work? What's going to be its greater impact on society? Which types of public sector initiatives are expected as we progress towards the age of AI?

The program 's five aims were:

- To build a snapshot of the current scenario and aspirations for AI and robotics around the globe and in Finland.

- Proposing a target state that Finland will strive to achieve in the application of AI in cooperation with companies, research institutes, educational institutions and public organisations.

- Recommending steps that are necessary to achieve the stated targets. Particular attention must be given to the innovation activities of the business, preparedness for changes in working life, improved education and development of the skills of those on the labour market.

- Develop a plan implementation model which will ensure the effective execution of the operational programme.

- To prepare a proposal for the expansion of the task description and composition of the working group in order to enable it to develop the measures necessary for the long-term promotion of AI. Besides, to analyze the wider societal change related to digitalization and to propose solutions to the government. (Finland's age of Artificial Intelligence 2017; Work in the Age of Artificial Intelligence 2018.)

AI Finland created AI Forum 2018 as a platform to discuss AI with government leaders, policymakers, experts, entrepreneurs and industry representatives. The 2018 AI Forum was held in Espoo on October 8–9, 2018. The main conclusions of this Forum were: (1) capitalizing the potential of AI integrated into policymaking for European industry; (2) AI, maximizing cooperation; (3) competitive advantage through AI ethics; (4) artificial intelligence changes learning life and (5) scaling research excellence and attracting rising stars (AI Forum 2018).

In May 2018, Finland signed the Nordic-Baltic regional Agreement on AI (Denmark, Estonia, Finland, the Faroe Islands, Iceland, Latvia, Lithuania, Norway, Sweden and the Åland Islands). These countries have agreed to work together to develop and

promote the use of artificial intelligence in the service of citizens (AI in the Nordic-Baltic region 2018). Final report of Finland's Artificial Intelligence, published on 14 March 2019 (Edelläkävijänä tekoälyaikaan [Leading the way into the Age of Artificial Intelligence] 2019) comments that getting Finland into the Artificial Intelligence Age (AI) requires ongoing capacity building, public discussion of AI ethics, as well as ambitious choices and investments. As a concrete step, the report recommends investments in data and AI usage, especially in business - to - business markets where Finland already has strong leading expertise. It suggests to attract top Finnish experts and increase skills across the enterprise, including management. It also proposes examining the possibility of awarding a voucher for AI training or creating a career account for each person of working age. In Finland, this would create an effective market for adult education. The final report deals in depth with different themes, or keys, with recommended guidelines on how to use AI in Finland. It also presents a vision of Finland in the 2025 AI age: “a nation that is attractive and competitive, and has educated and independent people with relevant education”. (Leading the way into the Age of Artificial Intelligence 2019.)

2.3 Futures research

The future and the idea of life have become major subjects of philosophy, theology and science, and this has always eluded the best minds to describe the potential futures (Hastings, Selbie & Gray 1908, 335). Many of the philosophers assumed the potential was expected and be the reverse of the past or the predicted timeline. The future, in physics, is only half the timeline, a fourth dimension. Religions look to the future when coping with issues like karma and life after death. In art, the future is discussed at the beginning of the 20th century through numerous history movements, such as the futurism art movement. Rescher (1998) suggests that rational inference can become feasible only if the future is already foreshadowed in the apparent trends of the past and present. Patterned regularities of natural occurrences generally come in the form of structured processes. Make-up and conduct of the future are essentially prefigured in the present physical endowment of the development of nature, conditioned into the prior state of things by the action

of natural laws. For rational prediction, this aspect of reality is crucial (Resher 1998, 69-70). Futures methodology has the aim of continuously exploring, constructing and evaluating possible and optimal futures to enhance decisions. This provides an overview of how things could transition as a result of policies and actions being implemented and the effects that they could potentially incur.

Future work can be oriented in the near or distant future to significant or small-scale issues; it can predict situations that are possible or desired. Industries are using futures approaches to improve their knowledge of future economies. Social leaders use these to develop and test potential goals that are both possible and desirable. Potential expectations can help produce long-term policies, strategies, and solutions that can provide better compatibility with expected, and probable future circumstances. Using futures methods increases anticipatory awareness, which in turn strengthens foresight to move more rapidly or faster to make the company or person more efficient in dealing with change. The ability to anticipate gives extra time to better understand threats and opportunities, develop more creative strategies, create new opportunities for the product, and realise a shared vision for organizational change. Future research's value is less in predicting accuracy than in planning and opening minds to consider new opportunities and change the policy agenda. Its purpose is not to know the future but to help the social actors make better decisions today through its methods that force them to anticipate opportunities and threats and to consider how to deal with them. On a strategic level, rather than just responding to change, it is more considerate to anticipate. (Glenn 2010.)

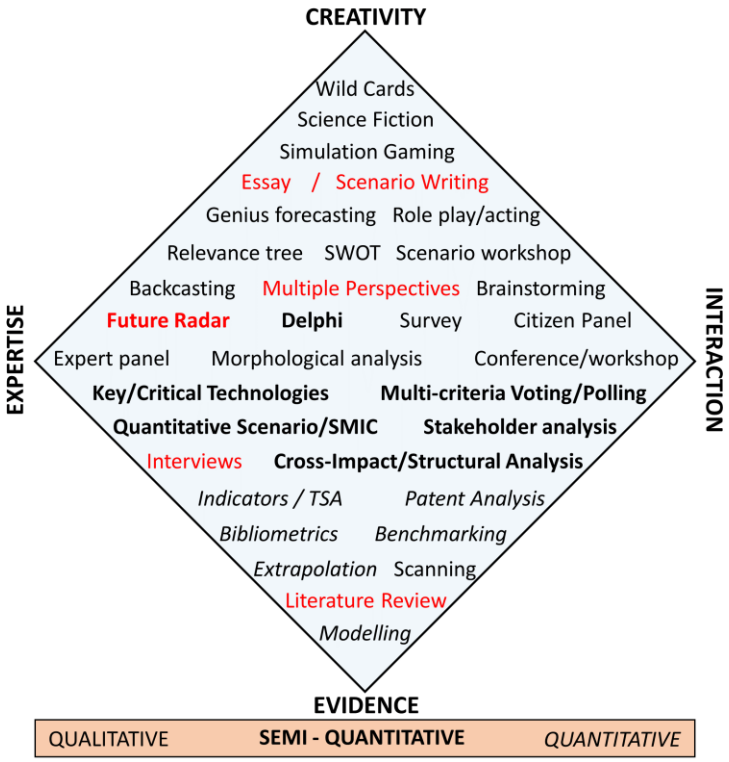


Figure 3. The Foresight Diamond contextualized for this study (Adapted from Popper 2008). The methods chosen are highlighted in red

There are several possible classifications of the futures research methods. For an illustration of the taxonomy of the futures methods in this study, the author chose the framework developed by Popper (2008), the Foresight Diamond. This framework allocates some of the more widely implemented futures research methods based on their main type of knowledge source, creativity, expertise, interaction and evidence. Methods based on creativity usually require a mix of original and creative thought, often delivered by "gurus" in technology, through genius forecasting, backcasting, or essays. Expertise-based methods rely on individuals' skills and knowledge in a given area or subject. Also, these approaches are used to support top-down decisions, offer advice and make recommendations. Expert panels and Delphi are common examples, but approaches such as roadmapping, trees of interest, logic maps, morphological analyses, key technologies and SMIC are essentially expertise based. For at least two reasons, interaction-based approaches are included in the foresight – one is that knowledge often benefits considerably from being put together and challenged to communicate with other expertise (and indeed with the opinions of non-expert stakeholders); the other is that foresight takes place in communities

where democratic ideals are common and legitimacy requires "bottom-up" approach. Workshops on scenarios, voting and polling are among the most widely used methods here; these often require some kind of practice to apply the method and inform the interactions. Evidence-based approaches try to explain and/or predict a specific phenomenon with the help of reliable documentation and analytical tools. Such exercises are particularly useful in understanding the actual state of development of the research issue. For this reason, quantitative methods (for example, work on benchmarking, bibliometrics, data mining, and indicators) have become popular given that statistical data or other types of indicators support them. (Popper 2008.)

The methodological framework used in a foresight project should be tailored to meet the project's specific aims and the requisite resources and capabilities. Many of the methods described above can be used in a foresight process at different stages and practitioners should consider (a) the contribution of each in the context of the study as a whole, and (b) how individual methods can be combined and synthesized to positive effect. No "ideal" methodological framework provides the "perfect" mix of methods. There is no "ideal" number of methods to use in a project. (Popper 2008.)

In the process of this study, the author chose a combination of five futures research methods to administer a qualitative study in one sequence: literature review, interviews, Multiple Perspectives, Future Radar and scenarios.

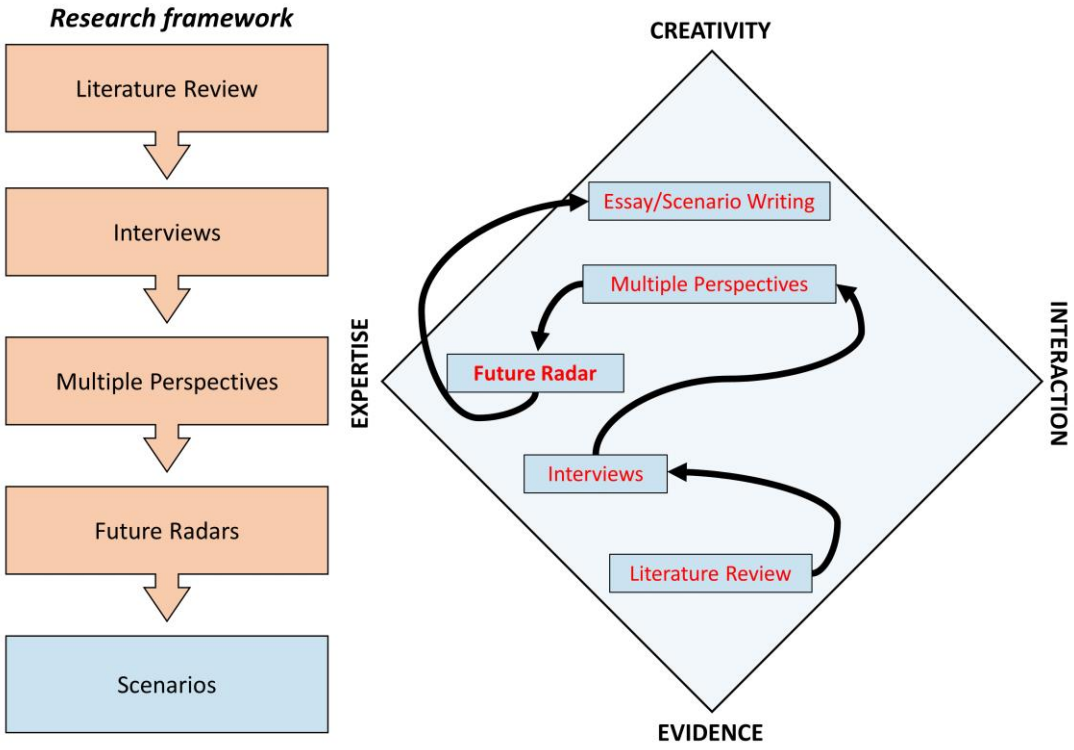


Figure 4. Research framework (forward method) (Adapted from Popper 2008)

1. Literature review: formulation of a theoretical base from the previous research on the same or similar topics in the industry;

2. Interviews: compiling primary data through conducting semi-structured in-depth interviews to collect relevant expectations and future anticipations from the research sample;

3. Multiple Perspectives: coding and analysis of the garnered data set across technical, organizational, and personal perspectives;

4. Future Radars: identification of preeminent trends integral to the studied phenomena and their following visualization;

5. Scenarios: finding patterns across the data set and constructing several potential futures.

These methods are examined in more detail in the following sections.

2.3.1 Scenarios

Scenario analysis presents a method for constructing various possible future sequences of events which can serve as a reference for current lines of action. Scenarios can vary in nature by how realistic they are. Explorative scenarios are based on past events, replicating them into the future. Set variables are usually taken into consideration and modified in order to produce different scenarios. Normative scenarios address the construction of scenarios from the viewpoint of the end results. They continue their journey to the present day from the end-result. (Gaßner & Kosow 2008.)

Scenarios may be used by divisions or for a single branch of the business. The best inventions are usually found outside of the own branch of the company. Vision also has a strong connection to scenarios as the situation can be a hazard or possibility (Mannermaa 1999). Good scenarios are the ones that give clear relevance to possible future events. By adjusting strategy and goals to represent anticipated changes, the organisation must forecast and prepare for these happenings. Companies should be at the centre of change as an agent of change rather than just waiting for tides to turn and react to alterations that have already taken place. For a company using scenarios as a predictive tool, the constructive role is more effective than a reactive role (ibid).

According to Jerome Glenn and The Futures Community (2010), the scenario-making process contains three steps: planning, production along with monitoring, and use. The first phase, planning, decides space for the scenario. The domain of interest is identified with the key driving forces deemed important to the area. The second step is adaptation. This step defines key measures, such as economic growth, the diffusion of technology or productivity. The third step includes identifying potential events, forecasting the key actions and writing explanations. Part of the process of scenario reporting and analysis includes documentation, comparing the consequences of alternate environments, and research policies.

2.3.2 The Futures Wheel

In 1971 Jerome C. Glenn invented the Futures Wheel method. According to Glenn (2010), this is a "method for the identification and packaging of secondary and tertiary trends and events". The Futures Wheel is a simple yet very effective way of exploring the future. It can assist in identifying potential issues and opportunities, services, products and new markets. Tactics and strategies are also useful in planning.

The Future Wheel is formed by writing in the centre of development or case. The key effects are inscribed in the first wheel layer or circle. Next, the secondary impacts are placed in the second ring of the primary impacts. Additional impacts can be added up until the picture is plain and ready (Glenn 2010). The Wheel of Futures is a great basis for further thinking and imagining the future.

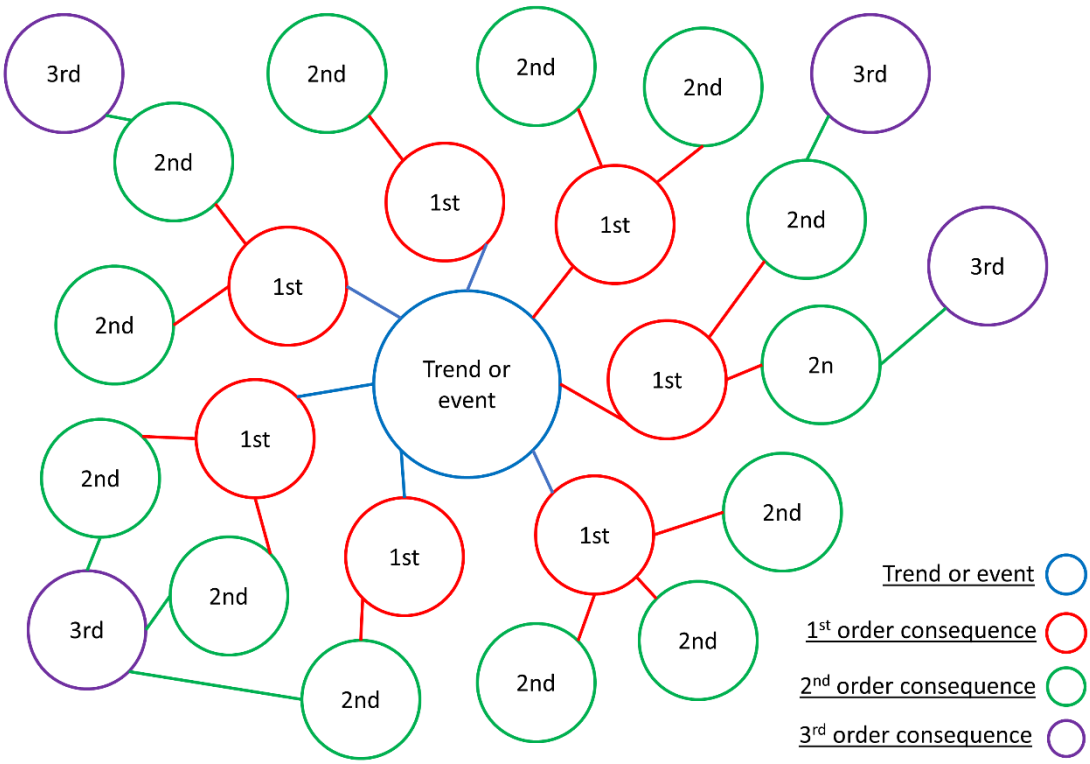


Figure 5. An example of the Futures Wheel (Adapted from Glenn 2010)

The Futures Wheel is commonly used in research into the future as it is a convenient way to engage people in thinking about the future. It is a very simple technique that

requires only a pen and paper. Glenn (2010) writes that the Future Radar is most commonly used to: think about possible impacts of current trends or potential future events; organize thoughts on future trend events; create forecasts in alternative scenarios; demonstrate complex interrelationships; show other future research; develop multi-concepts; cultivate a future-conscious perspective; help a planning group. The potential impacts or consequences are merely assumptions or ideas of the future.

2.3.3 Multiple Perspectives framework

Multiple Perspective Concept's first ideas can be traced back to Graham Allison's book on the Cuban missile crisis in which the issue was examined from three different perspectives, rational actor, organizational process and bureaucratic politics (Allison & Zelikow 1971). Harold Linstone, the concept's father, had seen that his analysis of corporate decision-making modelling was too simplistic for the forementioned process taking only some of the vital factors into consideration. In 1994 Linstone's book Multiple Perspectives for Decision Making was published from his own experiences and the impact of Allison's work (Linstone 1994) The Multiple Perspectives Theory is more of a methodology than a process and is also referred to as the Multiple Perspectives Methodology (Turpin, Phahlamohlaka and Marais, 2009). With three types of perspectives, the approach addresses scientific issues: technical (T), organizational (O) and personal (P) perspectives. The technical perspective stands for the science and technology world. The organizational perspective focuses on human beings in social groups and societies and their organization. Human beings trade their rights and responsibilities for incentives that a group or organization membership provides. The O perspective is more about the process and behaviour when the T perspective can concentrate more on the result and problem-solving. The P perspective deals with issues connecting people to the environment or the system and it uses a unique person's view.

Table 1. Characteristics of Multiple Perspectives by Linstone 1994

	Technical (T)	Organizational (O)	Personal (P)
World view	Science-technology	Unique group or institutional view	Individual, the self
Objective	Problem-solving, product	Action, process, stability	Power, influence, prestige
Systems focus	Artificial construct	Social	Genetic, psychological
Mode of inquiry	Observation, analysis, data and models	Consensual, adversary, bargaining and compromise	Intuition, learning, experience
Ethical basis	Logic, rationality	Justice, fairness	Morality
Planning horizon	Far (low discounting)	Intermediate (moderate discounting)	Short for most (high discounting for most)
Other descriptors	Cause and effect	Agenda (problem of the moment)	Challenge and response, leaders and followers
	Optimization, cost- benefit analysis	Satisficing	Ability to cope with only a few alternatives
	Quantification, trade-offs	Incremental change	Fear of change
	Use of probabilities, averages, statistical, analysis, expected value	Reliance on experts, internal training of practitioners	Need for beliefs, illusions, misperception of probabilities
	Problem simplified, idealized	Problem delegated and issues and crisis management factored	Hierarchy of individual needs (survival to self-fulfilment)
	Need for validation replicability	Need for standard operating procedures, routinization	Need to filter out inconsistent images
	Conceptualization, theories	Reasonableness	Creativity and vision by the few, improvisation
	Uncertainties noted	Uncertainty used for organizational self-preservation	Need for certainty
Criteria for "acceptable risk"	Logical soundness, openness to evaluation	Institutional compatibility, political acceptability, practicality	Conduciveness to learning, time-space distance to event
Scenario types	Probable	Preferable	Possible
Criterion	analytic (reproducible)	value	image
Orientation	exploratory (extrapolative)	normative (prescriptive)	visionary
Mode	structural	participatory	perceptual
Creator	think-tank teams	stakeholders	individuals
Communications	Technical report, briefing	Insider language	Personality, charisma desirable

The concept is pragmatic, unfinished and concerned with nature explicitly. Linstone has stated as a weakness of this method the possibility of lacking some relevant perspectives, different time horizons of the perspectives and the background of the individual that may affect the processing of perspectives (Linstone 1994).

2.3.4 Future Radar

Radar as a tool for presenting foresight knowledge emerged in the form of Cisco Technologies Corporation's Technology Radar, described as a foresight system for identifying, selecting and verifying social change and its impacts. Social change can be caused by a variety of factors, not necessary sociological. Technology is oftentimes referred to as one of the core drivers of social change (Cuhls, Kolz & Hadnagy 2012). Tools such as Radars serve not only as mean for data extraction and display, but also as a transformative force for seeing the operational environment with its drivers, threats and opportunities.

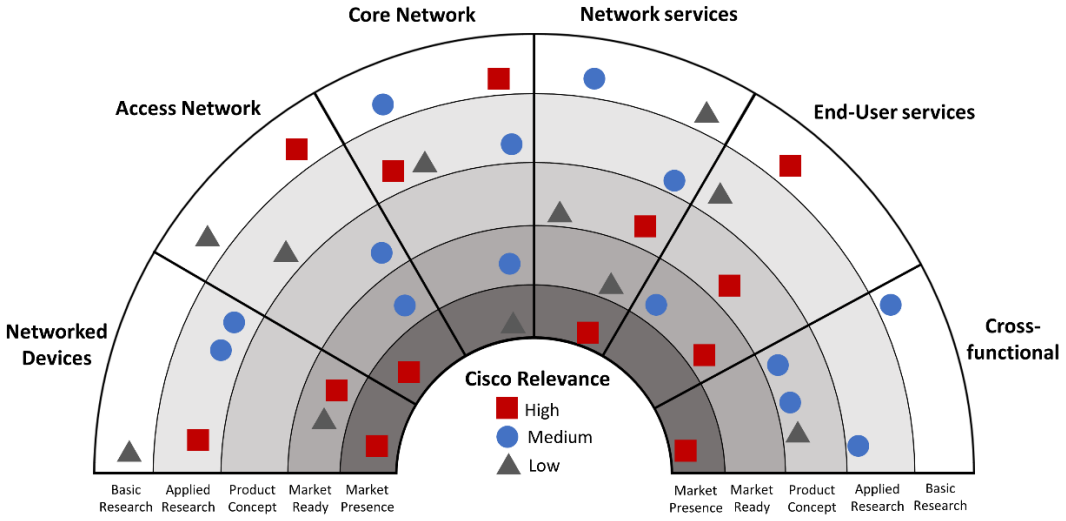


Figure 6. Example of Technology Radar (Adapted from Boe-Lillegraven & Monterde 2015, 72)

The Technology Radar process is typically divided into four stages: technology identification, selection, evaluation and dissemination to relevant stakeholders of the information generated (Cuhls et al. 2012). There is usually a vast number of technologies defined by a broad number of "scouts," therefore some structure and

order are needed. Typically, in the case of companies, the radar view is divided into business units or technology areas, and the timespan of becoming an individual technology (from the current moment) and an important variable is shown today in the distance of that technology to the "centre" of the radar image. Companies like Cisco also evaluate the strategic importance of the technology to their business (shown as various symbols on the radar).

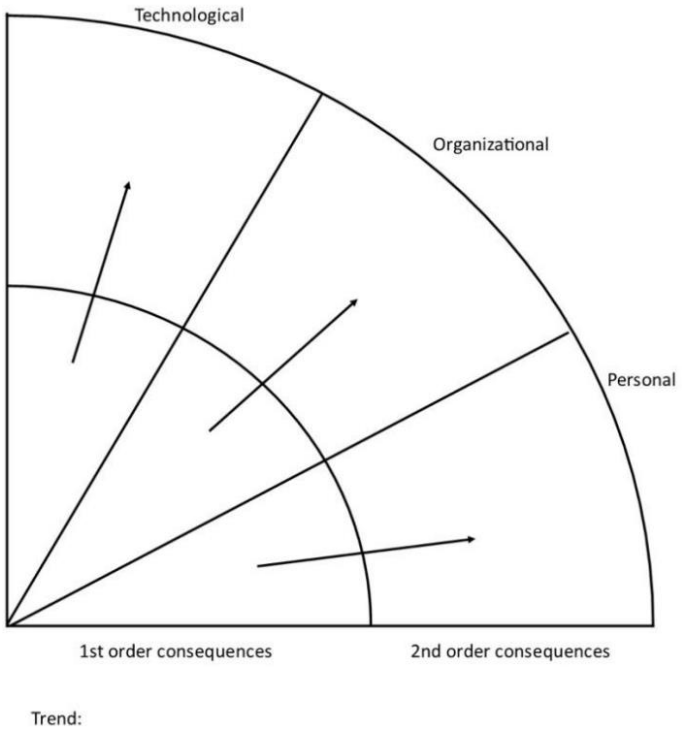


Figure 7. Future Radar by Saukkonen, Lundén 2018

The Future Radar was designed by Saukkonen, Lundén (2018) on the following principles: (1) It retains Futures Wheel's 1st and 2nd order effect framework; (2) It positions the identified key drivers, trends, to the "quarter wheel" epicentre; (3) It preserves the Technology Radar's image segmentation, but uses the multiple perspectives (Technological, Organizational, Personal) as respective segments. This study follows this framework for Future Radar implementation incorporating amendments proposed by Lundén (2019) where a technological segment of the radar also incorporates the consequences related to the application of scientific knowledge for practical purposes.

2.4 Synthesis of the theoretical framework

This subchapter provides an overview of the secondary literature resources used in the formulation of the theoretical framework for this study.

The Finnish healthcare system comprises a large portion of Finland's economy being the biggest employer in the country (Statistics Finland 2018). This explains the reason for major investments in the industry as well as implies that the industry's performance could have an impact on the overall condition of the country's economy. The system itself is formed from several subsystems; municipal, private and occupational. There are 310 administrative units in the country across 18 regions in which the provision of healthcare services is managed independently in accordance with the policies of the Ministry of Social Affairs and Health (The World's Most Efficient Healthcare System 2018). For the research, it could mean that the opinions between interviewees across different regions or municipalities could differ on the prospective paths for AI development depending on the policies within their regions.

Primary health care is provided in the country via all three substems while the supply of secondary care services is realized mostly within the municipal subsystem through public health care. Therefore, citizens have several choices on how to meet their health-management needs falling into the realm of primary care. The choices are limited to the associated payments either from taxes or from personal expenditures and to the scope of the treatments that these systems can provide. In the context of this research, the potential impact of AI technologies for primary care in Finland could vary between different sub-systems. There are multiple stakeholders present in the healthcare industry that all have an impact on the procurement of the services of primary care. There is strong consumer advocacy in the Finnish healthcare market and it is perceived that the consumer agenda has the highest influence on the development of the medical services in the country (Griffin et. al. 2016).

Artificial Intelligence encompasses a broad range of sub-set technologies which determine its functions, such as deep and machine learning, image recognition, cognitive computing, to name a few. The development of the AI as a single technology is not an optimal representation of technology's capabilities because AI has different means of applicability (Takyar 2018). Thus, the potential impacts of AI's subset technologies should be evaluated separately for more detailed contextualization of the research findings. Nevertheless, the core functions of the technology remain the same across the board, so it is possible to refer to it in its broad term. AI technology heavily relies on the input data to produce any kind of results and to iterate its functions through a process similar to learning (Artificial Intelligence and Machine Learning in Financial Services 2017).

Certain types of AI can be evaluated based on the technology's reasoning capabilities. No restrictions will be imposed on what types of AI technologies should be analyzed during the study. However, the evidence from secondary literature resources may suggest what types of AI technologies are more likely to expect to be implemented – Artificial Narrow Intelligence, which is trained at a specific case or task; reactive computer which works only with the data from user's interactions and restricted memory AI which iterates on the stored information. Artificial General Intelligence and other types of AI with profound computational powers that represent cognition are very rare and almost currently non-existent (Yaninen 2017), nonetheless, the researcher should not deny the possibility to find evidence for the application of these AI types.

The history of AI development began in the 20th century and has gone through several stages since then. At the present time, instances of AI application can be seen across almost all industries with more companies experimenting with the integration of technology. Notably, this could imply that the application of AI in the healthcare industry might come from other industries or sectors. On the country level, the development of AI technologies is supported through Artificial Intelligence Programme under the Ministry of Economic Affairs and Employment. In the international context, Finland is a member of the Nordic-Baltic regional agreement on AI development (AI in the Nordic-Baltic region 2018).

Futures research methods are utilized in order to predict potential instances in the future through the administration of multiple techniques. The ones chosen for this study fall in line with the categorization proposed by Popper (2008) who suggests that a researcher should consider combining several methods to attain the results of better quality. The framework chosen for this study incorporates five methods, literature review, interviews, multiple perspectives, future radars and scenarios in a forward fashion, meaning that the anticipation process is combined in one sequence. (ibid.)

Multiple Perspectives is the process of evaluating the decision-making across three perspectives; technical, organizational and personal. It is used to assess the potential futures associated with a certain event or trend on its potential implications for these three segments (Linstone 1994). While Technology Radars are implemented to gauge the level of impact of a certain social change, Future wheels are used to visualize the consequences that the change could incur. Combination of these three futures research methods resulted in the development of Future Radar (Saukkonen & Lundén 2018) which was used in this study to assess the potential trends of AI adoption in the Finnish primary care.

To sum up, there are a lot of interdependent elements in the healthcare sector which may all have an impact on the quality of provision of primary care and the provision itself may largely vary across municipalities. Artificial Intelligence is a broad range of technologies capable of a certain level of intellectual reasoning. In different cases, AI can demonstrate specific capabilities, based on the sub-set technology in use. Futures research methods may provide the necessary structure and guidance of the research process to take these assumptions into account when generating research results. Combination of several methods is employed to conduct the necessary evaluations for devising of potential futures.

3 Methodology

A research methodology is one of the more significant parts of the research. Various tools and techniques that were implemented in conducting this research will be explained in this section. This indicates a systematic way of carrying out the research (Rajasekar, Philominathan & Chinnathambi, 2006). Since no conventional method of research could ever be applied for all scientific studies, the researcher will use the most applicable research methodology for this study (Ragab and Arisha, 2018).

Saunders, Lewis and Thornhill (2016) in their book "Research Methods for Business Students (Seventh Edition)" developed the onion research model which was recognized by the author as the most suitable approach for this study as it offers a systematic framework for gradually developing the thesis step by step (Saunders, Lewis & Thornhill 2016).

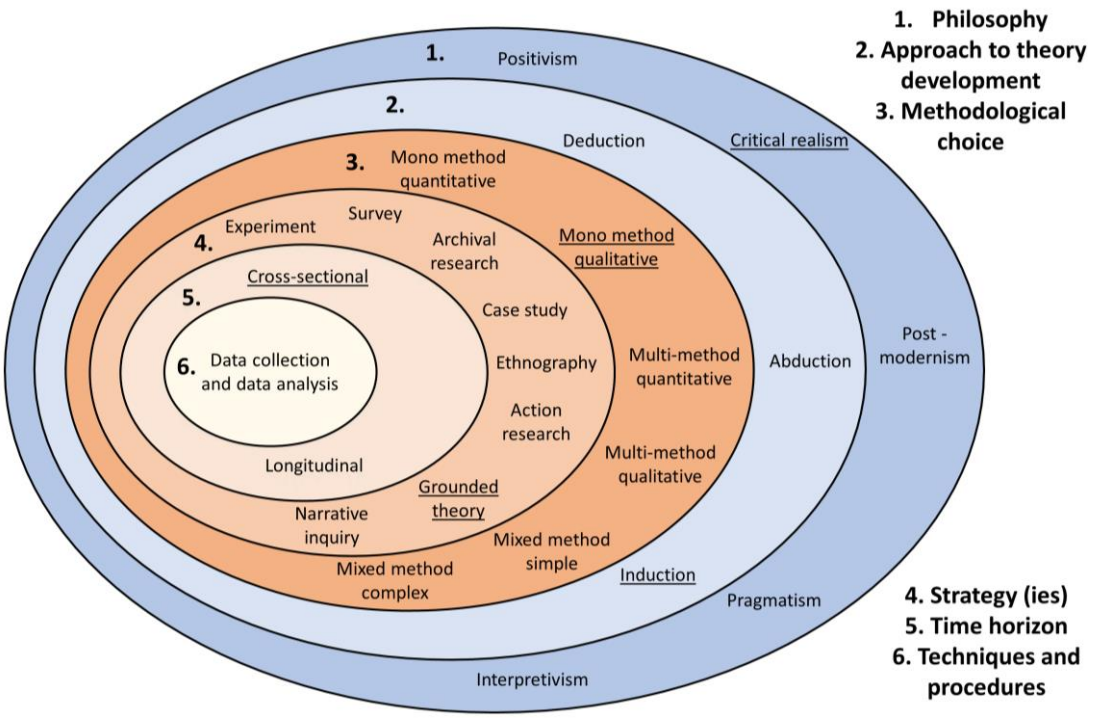


Figure 8. Research Onion (Adapted from Saunders et. al. 2016). The elements chosen for the study are underlined

3.1 Research Design

Saunders, Lewis and Thornhill (2016) define research design as “a general plan to address the various research questions”. In line with the research stages identified in the research onion, this section will explain the choices of the research philosophy, approach, strategy, and other research elements applied to evaluate the prospective directions of development of AI technologies in the Finnish primary care.

3.1.1 Research philosophy

In order to conduct the research in an organized and systematic way, certain beliefs and assumptions must be established as a basis on which the study gradually matures. The system of hypotheses and beliefs which is the basis for data collection and knowledge development is referred to as the research philosophy by Saunders, et. al. (2016). They propose five philosophical systems that can be practised in the business studies; they are interpretivism, critical realism, postmodernism, positivism

and pragmatism. Each of these philosophies can be adopted in three different forms: ontological, epistemological and axiological (Saunders, et. al. 2016). Ontology explores the nature of beliefs and their diverse features (Guarino, Oberle & Staab 2009), epistemology deals with the assumptions concerning the type of knowledge recognized in a philosophy (Al-Saadi 2014) and finally, the extent to which value and ethics play a part in philosophy is described in axiology (Saunders, et. al. 2016). All of these philosophies and philosophical stances comprise the upper layer of the research onion. The specifics of this study have prompted the researcher to analyze the study through the perspective of critical realism and ontological standpoint.

In the futures research, ontological assumptions about the reality of the expectations and beliefs can be studied through the concepts of *facta* and *futura*. *Facta* refers to scientific approaches associated with data collection about tangible past events and building predictions through extrapolation, while *futura* concerns the nature of cognitive products, being expectations, fears, wishes, etc. to which no mathematical models can be applied to ascertain projections about the future (Jouvenel 1967.) A critical shift in the ontology paradigms of future studies may be associated with Bell's (2003) introduction of the disposition concept. The core difference in understanding the future according to Poli (2011) was the concept of multiple possibilities, where the disposition is referred to as a fact that can be actualized in future under certain circumstances. Thus, the disposition is no longer a conceptual phenomenon from an ontological point of view, but rather a fact with the ability to influence the future. This study aims to assess the *futura* aspect of the research problem by looking at the hopes and expectations of the target research group that could influence the future development of AI technologies.

There are different ways of understanding the future and its relationship to the present and the past, within the field of future studies. Gabner and Kosow (2008) argue that the future can be viewed from three different perspectives: 1) the first perspective –- future is probable, anything that will happen is foreseeable; 2) the second perspective – future is evolutionary, thus it is impossible to control how it is realized; 3) the third perspective – future is moldable and therefore, participating actors can change its direction to some extent. Inayatullah (2013) offers a rather

similar interpretation of three fundamental views about the future: 1) predictive – it assumes deterministic futures, hence the future can be known; 2) interpretive – it suggests unpredictable futures the insight from which is primarily based on interpretative analysis of different images; 3) critical – there is no one predetermined future, but there are many possible futures. Kosow and Gaßner (2008) and Inayatullah (2013) propose nearly identical frameworks for the perception of the future, both of which can be attributed to three aforementioned philosophical positions in scientific research – positivism, interpretivism and critical realism.

Philosophy of critical realism is based on the following ontological principles: 1) the world consists of real entities; 2) we perceive images and experiences of real entities, not the same entities themselves (Saunders et al., 2016). It assumes the flexibility of the future and can be used to explain possible future constraints (Aligica, 2011). From the analysis of the works of futurologists on the implementation of critical realism in the futures studies, including Van der Heijden (2000), Bell (2003) and Patomaki (2006), the key assumptions about the philosophy applicable to this study can be summarized as follows:

1. Future as an entity, although not yet manifested, consists of multiple possibilities, which are updated through different events and nodal points, creating a particular context and requiring action for certain possibilities.

2. Social reality is an open system that contains components and dimensions, both observable, as well as unobservable, so precise scientific prediction as such is impossible. However, the future can still be expected, based on the observation of generative processes.

3. Awareness of the future is possible based on a logical deduction of past and present events. Examination of events creates conditions to discern a certain pattern of development, resulting in the analysis of its causal mechanisms and its potential extrapolation.

4. Analysis of prospects creates various accounts of how the future develops. The complexity of these narratives may comprise a representative portrayal of the possibilities for the phenomenon being investigated.

5. Future studies are concentrated on continuous processes and actions instead of past events, and therefore futurologists explain the development of the diverse social structures, identify the limiting conditions, and build a narrative to some extent up in the future through the formulation of scenarios.

This research emanates from the assumption that there is no one single predetermined future, rather a several possible futures realization of which is dependant on the actions of social actors at the current moment. Therefore, the philosophy of critical realism can be utilised as an ontological position to make future projections on the topic of this research.

3.1.2 Research approach

The approach to the research is decided on the extent to which theory influences the study. Three such approaches have been proposed by Saunders et. al. (2016). If research aims to test a certain theory and it is composed around that theory, it can be seen as a deductive approach. When a new theory is generated using the data collected, an inductive approach is selected. Third, the abductive, approach is a combination of inductive and deductive approaches. It is used in the testing and modification of an existing theory through data collection methods that are used in the identification of patterns (Saunders, et. al. 2016). Referring to Kuosa (2011) the same approaches are recognized in the futures studies: 1) deductive – targeted towards direct control of knowledge and functions, involves the use of physical argumentation; 2) inductive – aimed at controlling information through categorization and structural argumentation; 3) abductive – focusing on identifying connections, structures, contexts and restrictions, involved cognitive argumentation.

The author chose an inductive approach for conducting this research. The primary objective of this study is to ascertain the projected directions of development of AI-

based solutions, thus, the development of new theory is in the core of the administered research process. This approach will aid in the process of data collection and the generated findings will then be analyzed to develop a theoretical position which will become the final result of this study.

3.1.3 Methodological choice

Saunders et. al (2016) distinguish research choices based on the use of quantitative and qualitative research methods, their adoption in a form of mono methods as well as the simple or complex mix of both. The quantitative design uses tools that collect numerical data, while qualitative design collects non-numerical information. In contrast, the mixed design uses numerical and non-numerical data to conduct a study (Saunders, et al. 2016). Mono methods are used when research is focused on the collection of quantitative or qualitative information; mixed methods – quantitative and qualitative methods are used to achieve different objectives and to overcome the limitations of the use of the single method; multi-method choice negates the use of both qualitative and quantitative methods, although the research is based on of them, the alternative method is complementary or auxiliary. According to Saleh et. al. (2008), the spectrum of these methods is also applicable to future studies, where both quantitative and qualitative practices are implemented. Trend analysis, time series analysis, causal analysis, trend analysis are examples of quantitative methods and future wheels, Delphi surveys, environmental scanning are examples of qualitative.

This research is based on the mono-method qualitative methodological choice as the main data that will be gathered in the research will be the statements of the interviewees which are further analyzed within qualitative frameworks of futures research – representation in the form of Future Radars and formulation of scenarios.

3.1.4 Research strategy

Among research strategies presented by Sanders et. al. (2016), there are archival research, experiment, survey, case study, ethnography, action research, narrative

inquiry and grounded theory. Research strategy can be defined as a universal way for the researcher to choose essential data collection methods or combinations of those methods to answer the research questions and achieve the research objectives. However, in the field of futures studies, research strategies may have a slightly different interpretation. List (2005) recognizes two primary types of research strategies in futures studies – qualitative and quantitative. Besides these two types, Puglisi (2001), Kosow and Gabner (2008) distinguish explorative and normative groups of research strategies. Explorative are intended at assessing multiple futures and examination of possible vectors of development, while normative strategies are intended to define the desired/undesired future and build a chain of events or paths for making it possible. In futures research, these groups of strategies can be used for achieving specific research objectives – prescribe the actions required to attain a specific future; describe the concrete trends of future development, what the future will be comprised of; to explore the potential advancement of future events. Consequently, three primary research strategies can be singled out – normative (prescriptive), descriptive and exploratory. The purpose of this research to study multiple futures associated with the development of AI technologies in the Finnish primary care is fulfilled through exploratory strategy and implementation of grounded theory.

Exploratory research is described as research used to investigate a problem that is not distinctly identified. It is undertaken in order to gain a better understanding of the current problem but not to produce conclusive results. While administering the exploratory strategy, a researcher begins with a general idea and uses the research as a medium to identify topics of concern that can become the focus for future research. A significant postulate that can emerge in this case is that the researcher should be inclined to adjust the direction of the explored subject based on the discovery of new data or revelation of new insights. Exploratory research is usually conducted when the analyzed problem is at its preliminary stage of development and not much previous research has been done on the topic which is exactly the condition for this research. Previous research has examined separately the future of healthcare and the future application of AI technologies, however, no research has

yet focused specifically on identifying the trends for the maturity of AI technologies in the Finnish primary care and its ensuing consequences.

Anselm Strauss and Barney Glaser developed the grounded theory concept based on the belief that theory can emerge through qualitative data analysis (Strauss & Corbin 2008). The researcher goes through several phases in grounded theory which are multiple stages of collection, refinement and categorization of the data. According to the literature, the development of grounded theory relies on the inclusion of strategies of applying theoretical sampling and making constant comparisons (Locke 1996; Taylor and Bogdan 1998; Creswell 2007). Grounded theory research involves the careful application of specific methods and processes, which generate an ongoing, iterative sequence of actions and interactions implicit in grounded theory. The thorough implementation of critical grounded theory techniques refines the research leading to the creation of an integrated, comprehensive theoretical base that describes a process related to a specific phenomenon. The results of a grounded theory study are conveyed through a set of interrelated concepts which express the creation of a substantive theory. The hallmark of this strategy is thus, the generation of research findings "grounded in or abstracted from the data collected by the researcher". In the context of this study, grounded theory is implemented to devise potential futures description of which emerges from codification and refinement of conceptual findings from the research dataset.

3.1.5 Time horizon

Time horizons in future studies generally refer to periods to be explored or to a varying breadth of chronological horizons. Gabner and Kosow (2008) differentiate three basic time horizons: short-term – the study analyzes the period of up to 10 years; medium-term – up to 25 years; long-term – the study assesses the impact of the research phenomenon for more than 25 years. The authors also distinguish static observations from a certain point of time in future, commonly correlated with normative research strategies as an alternative time horizon. Such retrospective backtracking is generally used for "end-state" or "static" scenario planning (Gabner & Kosow 2008.)

The cross-sectional time horizon was chosen for this study. It involves the study of a research phenomenon at a given period and intends to characterize it or clarify the factors related to the development of the phenomenon. On this account, the research is aimed at representing the expectations of the research sample related to the future of AI development in the Finnish primary care on the moment of data collection. The timeframe that this study is expected to evaluate is short-term, up to 10 years from the moment of collecting data. The upper limit of the set horizon, 2030, serves as a mean of navigation for the research process and does not influence the scope within which the research findings will be generated. The author decided to proceed in such a manner from the assumption that the research can potentially produce findings outside of the set scope. Should it be the case, any estimations about the future outside of the chosen timeframe will be reflected in the analysis and in the discussion of the accumulated insights.

3.1.6 Research sample and sampling

A specific group of participants chosen by the researcher from the entire population to perform the study is called the sample; the selection process is called sampling. Various sampling techniques can be divided into two major categories, which are; probability and non-probability sampling techniques (Taherdoost, 2016). Judging by the exploratory nature of this study when it acts as a medium for identifying potential issues for future research, the non-probability sampling technique was chosen. Saunders, et. al. (2019) identify five non-probability sampling techniques; quota, purposive, snowball, self-selection and convenience sampling.

Purposive or judgemental sampling technique was implemented by the researcher to find a population sample with particular expertise in the field that would be able to provide multiple perspectives on the topic of this study. The choice for the technique is further reinforced by the fact that there is a limited number of specialists that could provide an opinion on the implementation of AI technologies in the Finnish healthcare industry. In order to avoid the researcher bias mostly prevalent when choosing the candidates for the population sample of the research, the researcher ensured that the participants of the study were representative of different

stakeholder groups present within the industry. In addition, the selective criteria for the research participants were guided by the chosen theoretical framework so that the candidates for the study would vary not only in their domain of expertise but also in their occupation and years of experience within their fields. Moreover, the goal of purposive sampling technique is not to select units from a population in a random way to form a sample with the intention of making further generalisations (i.e. statistical inferences in probability sampling). The main goal of purposive sampling is to select information-rich cases for study in depth from which one can investigate a great deal about topics of great significance to the purpose of the research, hence the name “purposive sampling” (Patton 1990, 169.)

There is a wide array of purposive sampling techniques that can be used; maximum variation, homogenous, typical case, extreme case, critical case, total population and expert sampling (Kuzel, 1999). During the course of this research, the author employed the combination of maximum variation and expert sampling types. Expert sampling was used to find individuals for the research that exhibit particular experience either in developing AI-based technologies or in the medical studies or a combination of both. At the same time, maximum variation sampling also known as heterogeneous sampling was applied to select participants from different organisations, units and industry sectors who can provide multiple perspectives on the topic of the research. Thus, the researcher made certain that the formed population sample would be able to provide in-depth insights into the studied phenomenon by having candidates; who come from both public and private sector, who represent both developers and appliers of AI-technologies in the Finnish healthcare industry, who vary in the years of expertise and who are representative of different stakeholder groups typically found in the industry.

As a matter of evaluating the representability of the stakeholder groups within the sample, the author referred to the stakeholder categorisation diagram within the healthcare industry developed by The European Connected Health Alliance (ECHAlliance 2018). The choice for this model was influenced by the fact that several Finnish regions are running members of the ECHAlliance, for instance, KeHO - Central Finland Health and Wellbeing Ecosystem, which means that the suggested

categorisation can be applied to inform the choice of the participants for the research.

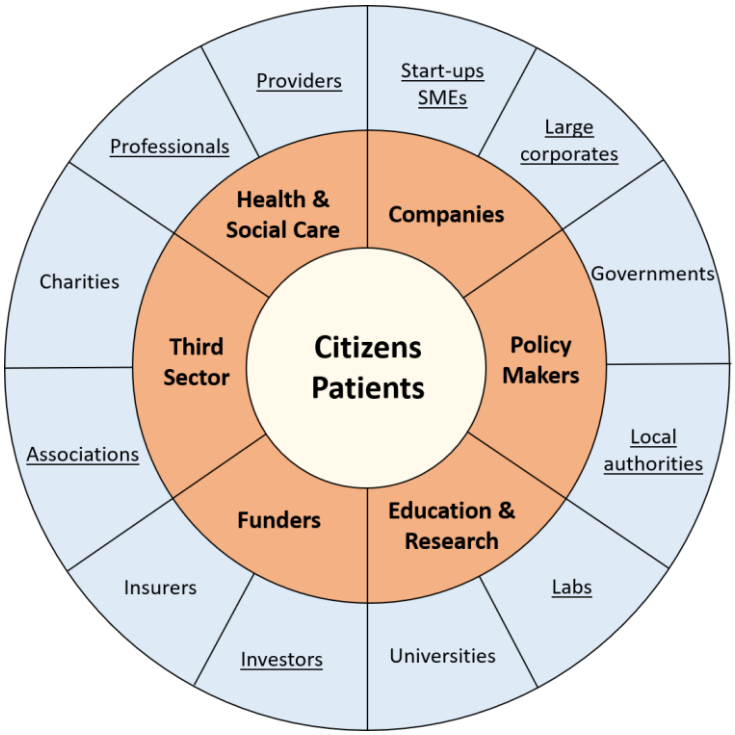


Figure 9. Stakeholder map of the healthcare industry (Adapted from ECHAlliance Ecosystems 2018). The representatives of the research sample are underlined

Overall, the research sample was formed by 13 stakeholders relevant to the topic of study who participated in semi-structured in-depth interviews. The full list of the pseudonymized research participants with only indirect identifiers agreed to be shared by the interviewees is presented below.

Table 2. Table of the research participants

Number	Code	Respondent's Domain	Profession	Stakeholder (according to ECHAlliance Ecosystems division)	Years of Work Experience within the Domain (of the Healtcare Industry - not always, for example ,see AI developers)	Date of the interview	Length of the Interview (hh.mm.ss)
1	1INC	Marketing automation and data analytics company	Manager of growth hacking tactics	International corporation	11	08.02.2018	00.50.20
2	2INC	Marketing automation and data analytics company	Chief in analytics	International corporation	9	08.02.2018	00.50.20
3	3HCP/LAB	State University Hospital	Chief physician of Primary Health Care Unit, member of the regional steering group appointed to manage the SOTE (Social Welfare and Health Care) reform	Healthcare provider / Lab	15	14.02.2018	01.31.12
4	4INV	Scientific research and business incubator	Director, member of the steering committee	Investor	25	16.02.2018	01.25.01
5	5SME	Software developer company (medical information systems)	Managing director	SME (100 employees)	20	21.02.2018	01.02.57
6	6PRO/ASSOC	Scientific association; Publishing company (electronic decision support systems)	Editor in Chief, Development Director	Professional / Association	32	21.02.2018	01.03.19
7	7INC	Healthcare company, specialising in chronic disease treatment	Clinical, Medical & Regulatory Director	International corporation	22	22.02.2018	00.51.35
8	8INC	Physiological analytics developer company (wearables)	Chief Executive Officer	International corporation	18	17.03.2018	00.48.24
9	9SME	AI algorithms and solutions developer company (semi-supervised machine learning)	Research engineer	SME (5 employees)	5	20.03.2018	01.03.21
10	10HCP/LAB	State University Hospital	Resident in neurosurgery; Manager of Microsurgery Center	Healthcare provider / Lab	5	20.04.2018	00.50.11
11	11INC	Developer company of AI-powered healthcare solutions	Chief Medical Officer	International corporation	12	30.04.2018	00.58.38
12	12POL/SME	State-owned development company (digitalisation of health and social services)	Program Director	State policy issuer / SME (40 employees)	6	28.06.2018	00.47.33
13	13HCP/LAB	State University Hospital	Living Lab project coordinator; Anesthesiologist	Healthcare provider / Lab	24	28.06.2018	00.49.29

Table 3. Codification of interviewees

Abbreviation	INC	HCP	LAB	INV	SME	PRO	ASSOC	POL
Stakeholder group	International Corporation	Healthcare provider	Lab	Investor	SME	Professional	Association	State policy

3.1.7 Data collection tools

Judging by the qualitative nature of this study and chosen inductive approach for futures research, the author looked for qualitative methods of obtaining research data. Interviews were chosen as the main method to collect empirical data necessary to provide answers to the research questions. There are several possible definitions of qualitative interviews. McGivern (2006, 184) interprets them as an "instructed conversation" in which the researcher tends to grasp perspectives, insights, attitudes and emotions on the research subject while Lindlof and Taylor (2011, 172) describe a qualitative interview as "purposeful conversation".

Qualitative interview administered one-on-one with an aim to delve into the subject in depth are coined as "in-depth interviews". In-depth face-to-face interviews are organized when a researcher needs to obtain detailed information on personal perspectives and behaviours, when the subject of research is delicate, or when it is not easy to find potential interviewees. In-depth interviews stipulate that the interviewer is well aware of the research goal, the theoretical framework regarding the explored issue necessary to support the conversation and the type of information that is being pursued. (McGivern 2006, 185-187.) Given that the conditions are met for respondents to answer freely in an open-ended way to the interview questions, the in-depth interviews have a potential to provide the researcher with relatively reliable and rigorous results related to the interviewees' attitudes and opinions on the research topic (Kananen 2011, 51). However, the process of conducting in-depth interviews can be time-consuming in regards to their execution and consecutive analysis. The quality of an in-depth interview is heavily reliant upon the researcher's prudence and his/her ability to navigate the conversation. (Ghauri and Grønhaug 2002, 102.)

Holloway distinguishes three types of qualitative interviews: structured, unstructured and semi-structured (1997, 94). Structured interviews imply that that the interviewer has a pre-determined set of questions to ensure that the interview process is conducted in a standardized fashion with limited divergence from the discussed topics and the interviewee is constrained in the provision of open-ended answers. Unstructured interviews, on the other hand, suggest that the interviewer refers to the set of questions as a mean to guide the flow of conversation allowing much more flexibility to the respondent in the expression of his/her opinion Semi-structured interviews are implemented when the researcher intends to receive comprehensive open-ended responses from the interviewee while adhering to the chosen set of questions with minor alterations. In the context of semi-structured interviews, one-on-one conversations are generally conducted in an informal tone in order not to project any unnecessary constraints or pressures associated with the research process on the person being interviewed. (Ghauri and Grønhaug 2002, 100-103.)

In this research, primary data collection is realized through semi-structured in-depth interviews with experts from the healthcare and information technology industries. The chosen tool for data collection facilitates the conditions essential for futures research when interview participants from the research sample share their assumptions and expectations that constitute the basis of future projections. Moreover, the choice for this tool is also influenced by the fact that semi-structured in-depth interviews are common in healthcare practice and themselves are “neither ethical nor unethical, neither emancipating nor oppressing’ which is suitable for the environment where the research is conducted (Kvale 2006, 497). Nevertheless, there are forces of influence inherent to the interview context that cannot be manipulated or minimized (Alvesson 2003, 169), thus the researcher had to take into account such potential influences, evaluate their impact on the generated research data and acknowledge possible variations in the interview experiences of all respondents. In the course of the research, such influences were manifested, for instance in the form of connectivity problems when conducting the interview on the phone or interviewee’s necessity to interrupt and reschedule the discussion mid-point based on his/her unexpected personal/professional requests. The researcher ensured that these instances did not have an impact on the final quality of the interview by taking

an active role in facilitating the conversation in a manner convenient for the interviewee and by securing the quality of the interview audio recordings for later transcription with minor deviations from the original session.

Representatives of the research sample were invited to participate in an interview through emails, telephone calls and messaging services, those being WhatsApp and Messenger. In the invitation letter, the research participants were introduced to the topic and background of the research, the main objectives of the study and key topics that will be discussed in the course of the interview. The interviews were organized both face-to-face and through telephone or video-conferencing services depending on the preferences and availability of the interviewee in question. The researcher recognized the value of face-to-face over distant conversations which is elucidated on the premise that the live presence of the interviewer and his/her influence on the research process as well as the visual cues communicated from the interviewee in the form of body language and other expressions can all have an impact on the quality of the collected data (Sanders et. al., 2019). Thus, whenever possible, the author of this study has travelled across the country where the research was conducted to the locations proposed by the interviewees to ensure that the credible conditions for conducting the semi-structured in-depth interviews have been met. The length of the interviews ranged between forty and ninety minutes depending on the personal disposition of interviewees and individual time necessary to provide answers to all of the interview questions. All of the interviews were recorded and notes highlighting specific aspects of respondents' statements were taken by the researcher in the course of the interviews. The transcription of the interviews was completed on the same or on the following day when the interviews were conducted. This was useful for the researcher to monitor the level of data saturation and to determine the knowledge and skills to be developed for the more proficient administering of the interviews to follow (Arksey and Knight 1999).

A clear and logical structure of the interview is a cornerstone of this qualitative data collection method. It should begin with an introduction, carry on to the main part and finished at an explicitly marked end. (McGivern 2006, 197-199). In this research, the interviews began with the exchange of greetings and making an acquaintance

between the researcher and the interviewee followed by an introduction to the topic and purpose of the research which aided in outlining the context of the study and in setting up the subsequent tone of the conversation. Before proceeding to the main part of the interview, the participants were informed about the specifics of the interview process, such as estimated length and presence of a continuous audio recording. The interviewees' preferences over confidentiality and recording permissions were taken into account and reassured before the interview's main part commenced. First set of questions explored personal experiences of the interviewees' related to the integration of AI-enabled solutions in the current area of their operations. Then, the conversation was directed to the questions regarding the perception of potential benefits and opportunities that the aforementioned technology can bring to the industry and its stakeholders. The discussed topic was then shifted to the anticipated impacts of the technology on the medical operations and interviewees were encouraged to foresee potential positive and negative consequences emerging from those impacts. The main part of the interview was finalised with questions focused on identifying plausible factors and parties that could channel the development of AI technologies in the Finnish primary care. The interviews were brought to an end by a suggested inquiry to share personal preparations in light of the anticipated future changes.

List of interview questions, interview invitation letter and an example of an interview transcript can be found in the Appendix section of the report (see Appendix 2, 3 and 4).

3.1.8 Data analysis tools

Qualitative data is often diverse and nuanced, and the findings of a qualitative study are focused on terms and definitions rather than uniform statistics. Proper qualitative data analysis requires considerable and thorough examination of the collected data (Saunders, et. al. 2016). One of the methods to analyze raw qualitative data was put forward by Huberman, Miles and Saldana (2014) which consists of three steps: data reduction, data representation and drawing conclusions. The first step corresponds to the simplification processes of the collected data to provide

summaries of the garnered information. The data is being reduced through the utilization of one of the applicable methods, e.g. data codification or categorization. The following step, data display, indicates the organization and presentation of the data aimed at identifying key trends as well as evaluating the relationships present in the dataset. The final step of the discussed method, drawing conclusions, is realized on the basis of critical analysis of assessed patterns and connections to formulate answers to research questions (Huberman et. al., 2014). This method illustrates a common approach to the analysis of collected data, albeit it is essential for the researcher to choose a specific method of data analysis and its associated procedures that fall in line with the overall research design.

Constant Comparative method

Based on the choices that led to the formulation of the research design suitable to answer the research question, the author selected the constant comparative method to analyze semi-structured in-depth interviews. The researchers use the constant comparative method to develop theories from the data through coding and analysis at the same time (Taylor & Bogdan, 1998). This method "incorporates the systematic collection, coding and analysis of data with theoretical sampling in order to create an integrated theory that is grounded in the data and expressed in a clear form for further testing" (Conrad et. al. 1993, 280). The constant comparative methodology consists of four stages; 1) comparing cases in each category; 2) combining categories and their characteristics; 3) identifying theory and 4) writing the theory (Glaser & Strauss 1967, 105). During the four stages of the constant comparative method, the researcher continuously sorts the data, analyzes and codes the information, solidifies theory development through the theoretical sampling process. The key benefit associated with the implementation of this method is that the research begins with raw data and through constant comparison, a substantive theory can emerge. At the same time, this method is considered to be labour intensive which demands from the researcher to invest time in the processed data collection and its further analysis. (Glaser & Strauss, 1967.)

Strauss and Corbin (2008) describe the process of analyzing data as coding. Coding consists of three levels of analysis: 1) open coding, 2) axial coding, and 3) selective coding, to assemble a complete representation of the information gathered during the data collection process.

1. The researcher is comparing data during this first step of the coding process and constantly asks questions about what is known and what is not understandable. Identifying different categories, properties, and dimensions within and among the dataset can be accomplished through a variety of techniques that systematically examine parts or the whole document. (Strauss & Corbin, 2008.)

2. The next coding phase is the axial coding where data is clustered together in new ways after open coding allowing for inter category connections. The researcher continues to ask questions and make comparisons which emphasize the deductive or inductive thinking employed in axial coding to relate subcategories to a certain category. (ibid.)

3. Strauss and Corbin define selective coding in the final stage of constant comparative method as the process of identifying and selecting the core category, systematically connecting it to other categories, validating those similarities and relationships and then completing categories that need further refinement and development. The grounded theory can only emerge after the process of critical incorporation of weaving and refinement of all the major categories into the selection of a core category. The concepts and relationships developed through the coding process that help guide the process of data collection and analysis are called theoretical sampling. (ibid.)

Constant comparative is an inductive method of theory development. In order to make theoretical sense of so much diversity in the data, the researcher is forced to develop ideas in conceptual abstraction on a level of a generality higher than the qualitative material being analyzed. The researcher is forced to identify bottom-line uniformities and diversities and use more abstract concepts to compensate for

results variations. In addition, the researcher is forced to commit to terminology reduction to master the underlying data. If the analysis is initiated from raw data, it will initially lead to the development of substantive theory, a hypothesis for the substantive area that has been researched. The constant comparative method can produce either propositional theory or a discussion. In the conducted review, the analyst might want to cover several properties of a category or write formal proposals about a category. The former type of presentation is often sufficiently useful in the exploratory stage of the development of theory, and the reader can easily translate it into propositions if a formal hypothesis is required. (Glaser, 2008.)

Scenarios

With a view to meet the research objectives in consonance with the futures framework of this study, scenarios and multiple perspectives methods have been implemented by the researcher. A scenario is a narrative that connects a portrayal of a specific future to present realities in a form of casual links illustrating decisions and consequences. A scenario is not a single forecast nor a prediction, but rather a way of organizing several assumptions about the future. It should be clear enough that a planner in question can properly identify and understand the problems, challenges and opportunities conveyed in this future environment. A scenario is not a prediction of a particular forecast per se, but rather a plausible description of what may happen. Scenarios describe events and trends that might develop.

The goal of generating scenarios is to understand the mix of strategic decisions that are of maximum benefit in the face of different uncertainties and challenges posed by the external environment. Building a scenario, in conjunction with careful analysis of the driving forces, encourages the systematic study of potential future possibilities — both positive and negative. This forecasting approach enables decision-makers and planners to grasp the long-term requirements for sustained advantage, growth, and avoidance of problems. Coates (1985a) implements the following process to depict scenarios. The key area of interest is defined first, then through a wide range of sources, key variables shaping the future are identified, on average, about 6 to 30 variables are devised. Eliminating redundancies, a process that usually results in 6 to

20 variables, will then winnow down this list. The scenarios are generated soon after based on the weighed out variables. Usually, a single scenario represents a continuation of the factors in play at the current moment (Coates, 1985b).

Schwartz (1991, 226-234) in his work “The Art of the Long View” describes several stages in the process of scenario development. These steps include: identifying the focal issue or decision; highlighting the key forces and trends in the environment; ranking the driving forces and trends by relevance and volatility; selecting the logic of the scenario; filling out the scenarios; determining the implications; and selecting the leading indicators and signs for tracking purposes (Schwartz 1992, 232-234). He also suggests that it is irrelevant to try to specify the “most probable” scenario. This reasoning is shared by other futurists that point out that the best scenarios represent a large number of variables and potential turns of events which form the dynamics of a studied system. A single sequence of events cannot determine the presumably predictable path through this labyrinth of twists and turns associated with the anticipation of the future. Auspiciously, the process of creation of a scenario does not focus on uncovering the most plausible prediction but rather on considering the range of feasible outcomes. The essential application of developed scenarios is centred around the assessment of future policies. (Martino, 1972.)

Multiple Perspectives

The framework of multiple perspectives suggested by Linstone (1994) was chosen by the researcher to administer the analysis of the qualitative data gained from semi-structured in-depth interviews. The application of this framework allowed the researcher to distinguish the critical factors that could impact the development of the research phenomenon. This method was particularly useful in the third stage of data analysis adopted by the researcher, drawing conclusions, when trends and patterns emerging from the investigation of the findings were interconnected across technological, organisational and personal perspectives. The analysis process was structured in accordance with the following guidelines proposed by Linstone (1994):

1. Each perspective offers insights that can not be obtained with the others. Together they provide a far more meaningful basis for decision-making than relying on any other perspective. Switching perspective types, i.e. from T to O and P, shifts paradigms and minimizes retention of the same assumptions and biases. Contrarily, the use of multiple perspectives shows with great clarity the severe limits in relying on a single perspective.

2. The T view appears to predominate in the early stages of a decision; the O and P viewpoints prevail in the processes of intervention or execution. There are often few individuals and organisations involved in the early stages of a decision process. Potential losers and gainers are still not identified. The work is often restricted to academic institutions, or to organising staff with a little personal stake. As the time for the decision approaches, the interested parties become clear and stances are taken, that is, perspectives O and P are formed.

3. O and P perspectives are case-specific, and tend to dominate phases of decision making and implementation. P is particularly effective when it comes to communication about complex systems.

4. Perspectives are dynamic and variate over time. Complex systems which involve people are rarely static. Their dynamic nature means that the organizational and individual actors change and that a given actor 's perspective can change over time. The multiple perspective process should be nonterminating in its ideal form. Although in the real world of decision deadlines this is impractical, it may sometimes be possible to revisit the process and configure the implementation accordingly.

5. Choosing viewpoints requires judgement. No collection of viewpoints is "right" or "complete". One can never take all opportunities into account. Decision making is improved in the acquisition and incorporation of viewpoints through sound judgement. The choice of data collection is heavily influenced by obtaining input to form cohesive and representable

> perspectives on a research question. For instance, one-on-one interviews are thought to provide the researcher with significant clues that can shed light on the organizational and personal perspectives corresponding to the connected technological outlooks. (Linstone 1994.)

To sum up, when the administered research has a methodology concurring with its philosophical stance, demonstrates compelling proof of validity and reliability in its data collection and analysis, exhibits reflexivity of the researcher in the process of planning, execution and interpretation of interviews and presents “a clear answer to the research question” (Arksey and Knight 1999, 49) then the results of such work may produce new practical insights that can contribute to the body of knowledge within healthcare and business research studies (Coleman, 2019).

3.1.9 Research ethics and verification of the results

Ethics

Research ethics signify moral values, principles and ethical standards that affect the performance of all the research activities and have an impact on the involved individuals. Interactions happening within the study between a respondent and a researcher are among the most sensitive in the domain of the research ethics. Participation in the research on a voluntary basis is considered ethical which was the case for all of the participants of this research. Silverman recognizes three most recurring issues in ethical guidelines of qualitative research which are trust, confidentiality and codes and consent (2016, 32). Trust element is an integral part of the interview process; it provides an appropriate field for conversations where the appearance of situational misunderstandings between researcher and participant that could distort the operational workflow is lessened. The trust is, in turn, built upon the informed consent of the research participants related to the research purpose and other essential information. No priority was given to any particular opinions from specific interviewees during the data analysis nor was the process of interpretation of results implemented during the discussion. The researcher acknowledged the advantages of the chosen data collection method and strived to guide the flow of the conversation in favour of interviewee sharing more of his/her

opinions that could be valuable for this study. At the same time, potential concerns associated with semi-structured interviews were taken into account, such as the potential for imposed bias of the interviewer on the research findings. The researcher was aware of the structure, timing and procedures of data recording in the process of conducting the interviews. The interviewer followed all of the instructions associated with governing of the interview process including the provision of a written and oral overview about the research under investigation, compliance with the interviewees' preferences over interview location and timings and adherence to the choices of the interviewees' regarding privacy and confidentiality (Eriksson, & Kovalainen 2008, 64-65).

Researcher's moral responsibility also involves plagiarism and implications of silencing. One should rely upon ethical rules and recognize other people's adopted publications, theories, etc. by giving them the credit in one's work (Eriksson, & 2008, Kovalainen, 74-75). In this analysis ethical issues are considered at every stage of the research process, not only during the acquisition of empirical data. The author is mindful of his duty towards research participants and therefore performs the analysis with diligence, precision and respectability. All theories, ideas and opinions mentioned in the research that did not come from the author of this study are referenced to the original author.

Confidentiality aspect compels researchers to protect the identity, location and other personal information of the research participants as long as the participants themselves do not wish for this information to be shared within the study (Silverman, 2016). Every research participant of this study agreed to share their personal information such as their occupation, years of professional experience and details about the company he/she represents in conformity with that no direct identifiers will be mentioned. Direct identifiers are conjoint to a person's identity; they include family and first names, postal addresses, telephone numbers and various types of identifications such as banking details, social security number and else. Indirect identifiers are types of data that can not explicitly describe an individual, such as gender, date of birth, regional postcode. Therefore, the information about individuals who participated in this study was pseudonymised, meaning the identity

of the subjects was substituted through codes (see Table 2). It will be inappropriate to assert that the researcher ensures the anonymity of the research participants if any indirect identifiers are present. (Spalding, 2018.) The author of this study wishes to express his gratitude to the research participants for providing invaluable insights that led to the formulation of these research findings and his appreciation of their decision to share some of their personal information that contributes to ensuring the validity of those findings.

Reliability

Reliability of qualitative research is usually linked to the trustworthiness of the undertaken methods and the credibility of the final results. The researcher's assumptions should be logical and transparent which implies that an independent reader of other researchers may be able to acquire the same or similar results that an author did. (Noble and Smith 2015.) The author took this into account and included clear descriptions of the research process in the report, provided justifications for methods and approaches chosen for the implementation of the research study, created a set of illustrations (figures) that demonstrate the research process in a comprehensive manner and acquired the secondary data from public sources. Transcription of the collected data is an imperative element for the reliability and accessibility of the information gathered through interviews (Luton 2010, 41). The author recorded all of the conversations during the interviews in order to ensure the integrity of the data gained and arranged the materials for further transcription. Transcriptions gave the author instant access to the collected data and helped to avoid any possible data loss and misinterpretation issues due to inaccurate data or analysis. This research also included access to secondary sources, such as websites and webpages. Reliability of the data assessed on the Internet was ensured through careful criterion for the choice of the appropriate websites. The author paid attention to the domains of the sites and checked the owner of the site to assess the source's reliability. Thus, websites of well-known organizations have been regarded as trusted sources: https://stm.fi/en/frontpage (Ministry of Social Affairs and Health); https://www.kela.fi/ (Kela digital health services); https://soteuudistus.fi/etusivu (Social Welfare and Health Care reform); https://thl.fi/en/web/thlfi-en (Finnish Institute for Health and Welfare);

https://www.businessfinland.fi (Business Finland). All of the secondary source information is public and open to all. Thus any reader or researcher can retrieve the data. In addition, the data was gathered from multiple sources to increase the reliability of the research results.

Validity

A research study's validity may be interpreted as a relevance of the employed tools of data collection and analysis. There ought to be a consideration for the applicability of different elements. For the achievement of the desired results, the research question(s) must be valid, the research design must be accurate for the methodology chosen, a researcher must take care of the appropriateness of the data collected and ensure that the results are valid for the sample and context. (Leung, 2015.)

To ensure the research validity, the author employed three validation strategies proposed by Creswell (2007): negative case analysis, clarification of research bias and external audit. Negative or deviant case analysis is a strategy of critical analysis through which the researcher refines working hypotheses as the research advances (Patton, 1990). The researcher modifies the initial hypothesis until all research cases fit, finishing this process late in data analysis and phases out all deviant cases and exceptions. Negative cases are intrinsic to the constant comparative method of data analysis which is used to establish grounds for comparisons between normal cases. These “deviants” are often perceived as a tool to monitor the development of theoretical assumptions in the conducted study, which augments rigour to qualitative studies. The complexity of the data should be welcomed as it allows for a subtler and more nuanced analysis. Data contradictions may produce unexpected findings which ultimately reinforce the theory. Qualitative researchers are actively looking for "negative cases" to support their claims. A deviant case is one where the perceptions or opinions of the respondents vary from the main body of evidence. When describing a negative case, the general reasoning for the "typical" situation is reiterated. The researcher has recognized several instances of negative cases that gradually appeared in the process of analysing the interview transcripts through a constant comparative method. Evaluation of certain statements of the particular interviewee that contradicted with the rest of analysed research findings provided

the pragmatic evidence necessary to ascertain projected futures on the topic of this study. Thus, the researcher was able to continuously monitor and assess the validity of emerging grounded theory in this study.

A research bias has an impact on the validity of the study. Several potential instances where precedent for bias can arise were distinguished by the researcher with those being research sample, reporting techniques, interview questions, researcher's communication skills and expertise of the researcher in the studied environment. Bias associated with the research sample was prevented through applied purposive sampling techniques, expert and heterogenous, which influenced the final choice of the participants. Interviewee candidates were chosen based on their qualifications and expertise relevant to the topic of study as well as experience of working in/with the healthcare industry, hence expert sampling. This bias was further minimized through the invitation of different stakeholders to share their expectations about future development which resulted in the formation of a heterogeneous research sample benign for the futures research. The bias associated with the researcher's interpretations or inappropriate administration of the chosen data analysis techniques was subverted through the critical implementation of constant comparative and multiple perspectives data analysis techniques guidelines of which were closely followed by the researcher.

The interview questions could also be considered as a potential precedent for the research bias, therefore, any polarizing questions were avoided and questions were assessed on the premise for any potential misunderstandings. The researcher conducted the interviews without sharing any suggested answers to the interviewees, thus, allowing the research participants to express their opinions in a fully open-ended manner. Communication skills of the researcher ranging from the language style to the body language were perceived as an integral element in the process of administering semi-structured in-depth interviews. It should be noted that the language of the interviews was not native to both the researcher and the interviewee; the researchers' native language is Russian, the interviewees' – Finnish or Swedish; the language of the study is English. In case of any misunderstandings or challenges in communication surfacing during interviews, appropriate translation

and conversation techniques were employed to guarantee shared comprehension. Apart from recognizing occasional emergent challenges in translation, the author of this study also admits his potential bias associated with the lack of professional or scientific background in the field of healthcare or artificial intelligence technologies that could have had an impact on author's judgements implied on the research findings. Nevertheless, the author employed a different validation strategy to ensure that there is no strong evidence for this bias influence research validity.

External auditing is used when the researcher turns to people outside the project, formally included in the study, such as auditors or readers who disregard the narrative account and attest to its credibility. The researchers provide clear documentation of all research decisions and activities when setting up an audit trail. They may provide audit trial evidence throughout the account or in the appendices. Researchers may also review their study using an external auditor. The purpose of a formal audit is to examine both the inquiry's processes and product and determine the finding's trustworthiness. (Creswell, 2007.) Researchers are establishing an audit trail documenting the inquiry process through journaling and memoing, keeping a research log of all activities, developing a chronology for data collection, and precisely recording data analysis procedures. This documentation is examined by the external auditor with the following questions in mind: Are the findings grounded in data? Are deductions logical? Is the structure of the category fitting? Can decisions regarding inquiries and methodological shifts be justified? What is the degree of bias in research? Which strategies have been used to build credibility? (Schwandt & Halpern 1998). The narrative account becomes credible through this process of documenting a study and having an external auditor review the documentation. The author of this study has referred to the consultancy of an external to this study acquainted medical professional. The researcher provided the auditor with excerpts from the research findings and logs of data collection which the auditor then evaluated. This person, who wished to stay anonymous, is involved in the integration of some of the latest technologies in medical operations and provided the researcher with the necessary guidance to assess the credibility of the research findings from the perspective of an industry representative.

Moreover, data saturation can be considered as the other prerequisite to the research validity. Failure to achieve data saturation affects the overall quality of the research being conducted and hampers the validity of the research results. According to Saunders et. al (2019), the term refers to a phase of the research when generated data no longer provides new insights into the field, or very little. In this research, data saturation was achieved after ten research participants were interviewed, and the following conversations scheduled with the interviewees were reinforcing previously mentioned expectations and concerns related to the application of AI in the Finnish primary care.

3.2 Research Process

This section will cover the research steps that the author of this study went through.

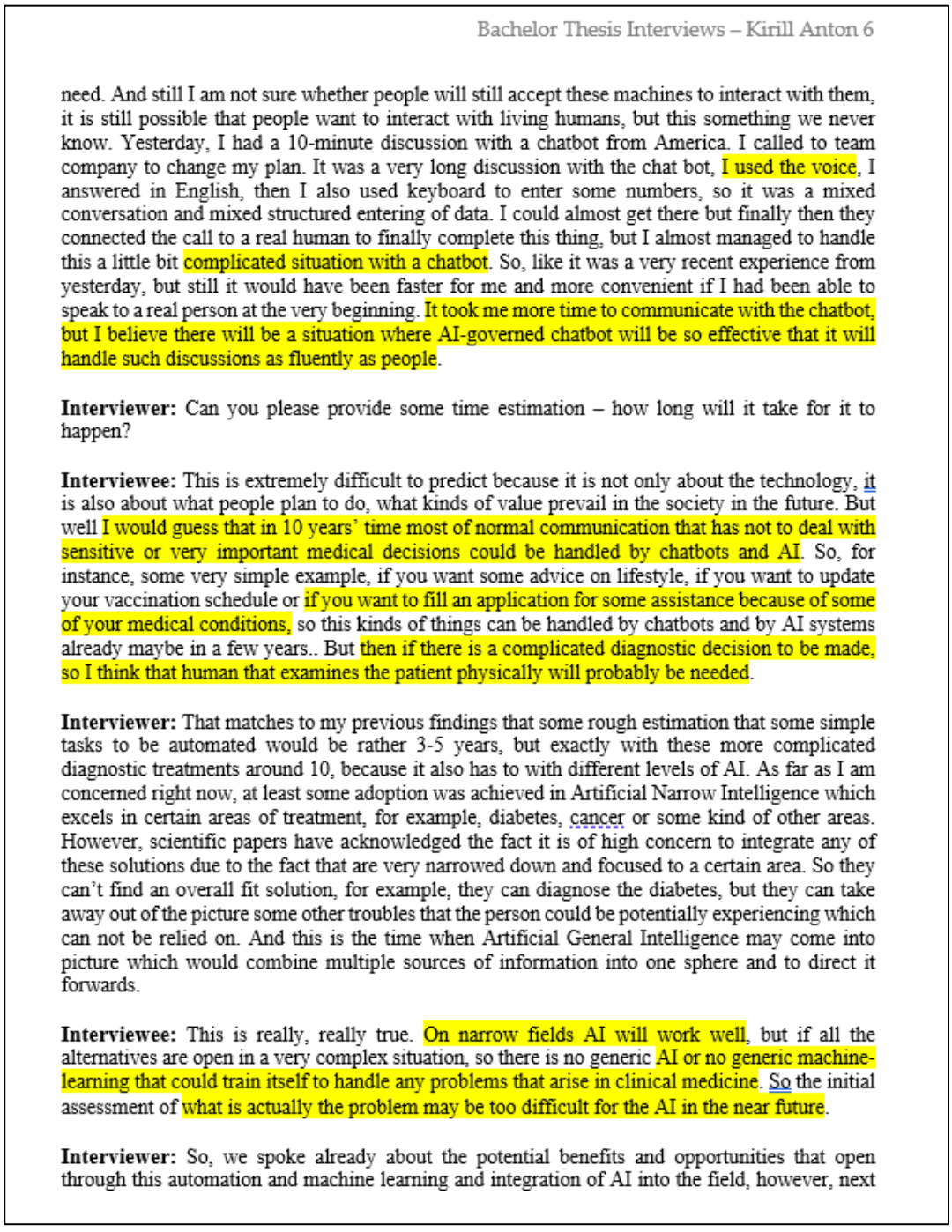
3.2.1 Research stages and timeline

During the research timeline, the author made the decision to re-evaluate the initial methodology chosen for this research. The details are explained further in this section.

Table 4. Research stages and timeline

Stage	Timeline
Creating a hypothesis for the research	January 2018
Choosing a scenario research framework for the study implementation	February 2018
Collecting data. Conducting and transcribing interviews. Data saturation is achieved	February – June 2018
Analysing data	July – December 2018
Re-evaluation of the research hypothesis based on the conducted analysis and on the nature of the collected data. Choosing an alternative method for data evaluation – Future Radars	January – July 2019
Re-analysing the research dataset in line with the newly chosen methodology framework	July – December 2019
Finalising the research	January 2020 – May 2020

At first, the author employed a constant comparison method to find out the sentences in the data set of applicable meaning to the research purpose.



Bachelor Thesis Interviews – Kirill Anton 6

need. And still I am not sure whether people will still accept these machines to interact with them, it is still possible that people want to interact with living humans, but this something we never know. Yesterday, I had a 10-minute discussion with a chatbot from America. I called to team company to change my plan. It was a very long discussion with the chat bot, I used the voice, I answered in English, then I also used keyboard to enter some numbers, so it was a mixed conversation and mixed structured entering of data. I could almost get there but finally then they connected the call to a real human to finally complete this thing, but I almost managed to handle this a little bit complicated situation with a chatbot. So, like it was a very recent experience from yesterday, but still it would have been faster for me and more convenient if I had been able to speak to a real person at the very beginning. It took me more time to communicate with the chatbot, but I believe there will be a situation where AI-governed chatbot will be so effective that it will handle such discussions as fluently as people.

Interviewer: Can you please provide some time estimation – how long will it take for it to happen?

Interviewee: This is extremely difficult to predict because it is not only about the technology, it is also about what people plan to do, what kinds of value prevail in the society in the future. But well I would guess that in 10 years' time most of normal communication that has not to deal with sensitive or very important medical decisions could be handled by chatbots and AI. So, for instance, some very simple example, if you want some advice on lifestyle, if you want to update your vaccination schedule or if you want to fill an application for some assistance because of some of your medical conditions, so this kinds of things can be handled by chatbots and by AI systems already maybe in a few years.. But then if there is a complicated diagnostic decision to be made, so I think that human that examines the patient physically will probably be needed.

Interviewer: That matches to my previous findings that some rough estimation that some simple tasks to be automated would be rather 3-5 years, but exactly with these more complicated diagnostic treatments around 10, because it also has to with different levels of AI. As far as I am concerned right now, at least some adoption was achieved in Artificial Narrow Intelligence which excels in certain areas of treatment, for example, diabetes, cancer or some kind of other areas. However, scientific papers have acknowledged the fact it is of high concern to integrate any of these solutions due to the fact that are very narrowed down and focused to a certain area. So they can't find an overall fit solution, for example, they can diagnose the diabetes, but they can take away out of the picture some other troubles that the person could be potentially experiencing which can not be relied on. And this is the time when Artificial General Intelligence may come into picture which would combine multiple sources of information into one sphere and to direct it forwards.

Interviewee: This is really, really true. On narrow fields AI will work well, but if all the alternatives are open in a very complex situation, so there is no generic AI or no generic machine-learning that could train itself to handle any problems that arise in clinical medicine. So the initial assessment of what is actually the problem may be too difficult for the AI in the near future.

Interviewer: So, we spoke already about the potential benefits and opportunities that open through this automation and machine learning and integration of AI into the field, however, next

Figure 10. Excerpt from one of the interviews' transcripts. Visual representation of the 1st stage of the constant comparative method administered during the study

Then the researcher proceeded to implement the second stage of the constant comparison method to codify the sentences and to categorise them in the

meaningful pieces of data – potential variables that can affect future in scenario planning.

Table 5. Tabular representation of the 2nd stage of the constant comparative method contextualized with findings from this study

Code	Citation of the statement
Increasing technological competences of doctors	widening the portfolio of competences to form new kinds of compositions in the industry and so on
Government plays an active role	the governments of course are interested in seeing – the renewing and building new solutions in the marketplace
New technologies are enabled through AI	plus they provide the web microscope technology
Issues related to digital security	Cyber-security problem, the more we have this kind of applications and in our own mobile devices
Doctors treat diseases more efficiently	new technologies allow doctors to participate in the chronic disease management more than previously
Administration of hospitals influences the adoption of new technologies	Necessarily it doesn't work at all, there is no making more or less this management opportunities for management of this chronic diseases, sometimes it is very-very good, and sometimes it can create obstacles or chasms between the patient and the doctor
Health data banks foster AI integration	utilizing all these advancement and opportunities that these databanks are opening and this digital data is providing
Potential for partnership between local and international companies	The government can make it so, that for example, the big companies, multi-nationals can partner with small companies that are actually building the solution for them – that's the way, that's one way
Medical intake influenced by conclusions provided by AI	AI solution for making a prediction, for whether I have high risk of something or it provides a solution what pharmaceutical product would be optimal for me for this treatment, then you are able to utilize data for that moment, not for eternity when for all

Overall, about 20-30 variables have been identified which could then be formulated in the axes for future scenario planning during the third stage of the constant comparative method.

Table 6. Tabular representation of the 3rd stage of the constant comparative method contextualized with findings from this study

Axis for scenarios	Variables for scenario planning
Level of investment into AI (high vs low)	• Major investments in healthcare into AI • Medium investments • Low investments
Level of governmental control over AI initiatives in the healthcare (privatisation vs nationalisation)	• Public companies develop AI solutions on a governmental level • Private companies provide their machine learning-enabled offerings • Combination of both
Consumer willingness to pay (low vs high)	• AI solutions are on a freemium model • On a subscription-based model
Customer/stakeholder resistance (low vs high)	• Too challenging to interact • Not user friendly • Easy access
Level of centralisation in the implementation of AI initiatives (centralised/decentralised)	• AI initiatives are nationalised • Local districts have their own AI initiatives
Degree of international impact on the economy financially and technologically (high vs low)	• Big international conglomerates impose their product offerings on the Finnish market • Local start-ups excel in AI development
Rate of technological development (slow vs fast)	• AI technologies are adopted very fast among consumer bases • The technology is scalable

After the potential axes have been identified, the author proceeded to the formulation of an appropriate scenario framework to represent the findings from the collected data set.

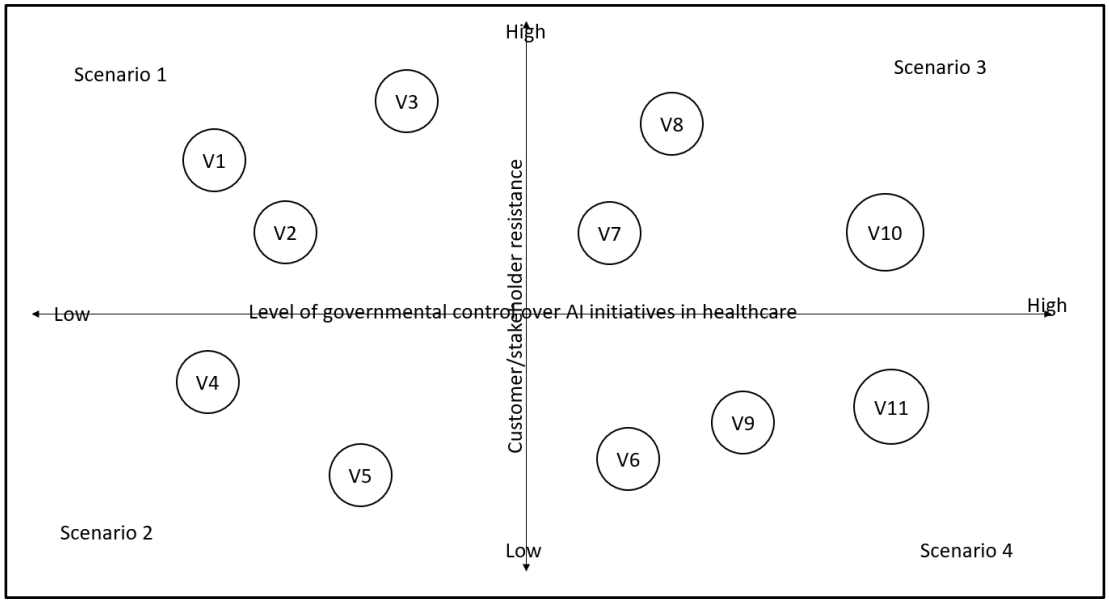


Figure 11. Conceptualization of potential scenarios, 1st draft

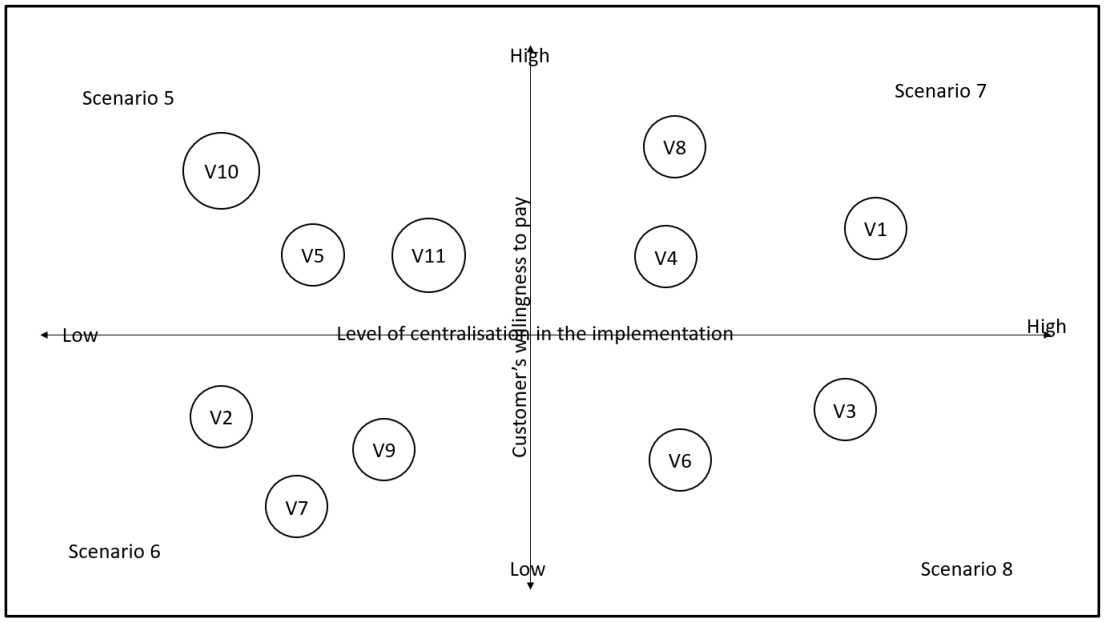


Figure 12. Conceptualization of potential scenarios, 2nd draft

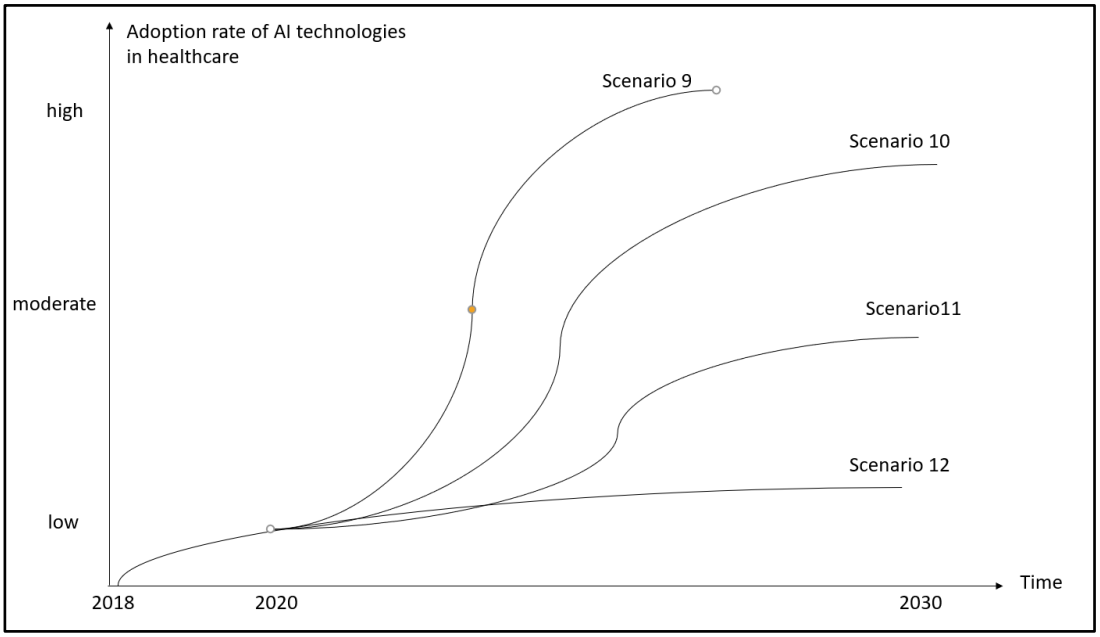


Figure 13. Conceptualization of potential scenarios, 3rd draft

In the process of conceptualisation of potential scenarios, the researcher found out that: (1) multiple axis for scenarios were identified during the 3rd stage of constant comparative method; (2) when attempting to disseminate the identified variables (20-30), some of the variables did not fit in the chosen axes for the scenarios and did not fit the set parameters; (3) the mixing of the axes between each other did not lead to finding an eventual solution that would allow all variables from the data set to be represented.

The author realised that whilst attempting to visualise collected dataset in form of scenarios, not all aspects and comments mentioned by the interviewees made it to the chosen scenario graphs, thus reinforcing the broadness and richness of the collected data. At least some of portion of the identified variables were left out when suggesting a certain range of scenarios, on that account, there was a need in change of methodology to better suit the collected dataset.

This was the main reason for the change in the methodology, however, not the only one. In the timeframe of conducting this research, the author realised that the domains within the healthcare industry have significantly changed. First, because of the postpone of SOTE reform implementation and second, because of the COVID-19

epidemic which put previously formulated scenarios under serious doubt (Considering the potential business impacts of the COVID-19 outbreak 2020). The scenarios drafted in 2018 were predominantly based on the interviewees' assumption related to the SOTE reform happening in the originally proposed time-schedule and the postponing of the reform has rendered based scenarios slightly less relevant. This assumption was further confirmed in the course of this study by consecutive research publications on the perceived impact of SOTE reform on the Finnish Healthcare (Filintseva 2019).

Therefore, the researcher came to a conclusion that new method for analysis and presentation of information needed to be chosen for the study that will: (1) allow representing the collected dataset in its full volume, not undermining any factors from the whole picture; (2) would not come from the assumption of possible futures (scenario type), but rather focus on the display of mindset and expectations of interviewees about the researched topic into the future.

Taking the above points into consideration, a decision was made to re-analyse the interview transcripts (the original dataset) through the Multiple Perspectives methodology and to use Future Radars as a way for data visualisation. In this way, it was possible to administer the research process that would not suppress any of the findings derived from the interviewees' original statements.

The constant comparative technique was again implemented in 3 stages to:

1. During the first stage, to codify interviewees' statements into consequences.
2. During the second stage, to group consequences into broader themes of the chosen framework – technological, organisational, and personal.
3. During the third stage to identify core trends ranging in those 3 perspectives that would become the foundation for Future Radars.

Here is a snapshot of the coding table used within this methodology mindset:

Table 7. Excerpt from the table of the research findings

	Trend 1 **AI in pre-diagnostic stage (chatbots)**		Trend 2 **AI during diagnostics (medical imagining)**		Trend 3 **AI in post-diagnostic stage (CDS)**	
	1st order consequence	2nd order consequence	1st order consequence	2nd order consequence	1st order consequence	2nd order consequence
Technological Perspective	Medical applications using AI are developed (**1INC; 3HCP/LAB; 4INV; 10HCP/LAB; 13HCP/LAB**) *T.1.1. – 5*		Development of new means for diagnosis (**2INC; 4INV; 5SME; 13HCP/LAB**)		Potential implementation within the realm of bioinformatics (**2INC; 4INV; 5SME; 8INC; 10HCP/LAB**)	
	With new technologies doctors can now monitor patients' health remotely – telemedicine (**2INC; 4INV; 7INC; 13HCP/LAB**) *T.1.1 - 6*		Integration of AI In virtual microscopy (**1INC; 3HCP/LAB; 4INV; 7INC; 8INC; 10HCP/LAB;**) *T.2.1 - 1*		AI implemented in treatment of cancer tumours (**1INC; 2INC; 4INV; 7INC; 8INC; 10HCP/LAB; 11INC**)	
	Machines can substitute initial consultancy and check-ups normally conducted by assistance health care personnel (e.g. in cases by		Diagnosis can be carried much faster (**1INC; 2INC; 4INV; 9SME; 13HCP/LAB**) *T.2.2 - 2*		Health and treatment-related information is stored in data banks (**3HCP/LAB; 4INV; 8INC; 12POL/SME**)	Cyber-security issues arise (**1INC; 4INV; 5SME; 7INC; 13HCP/LAB**)

The full table can be found in the Appendices (see Appendix 1).

4 Results

The research findings are summarised and visualised in the form of Future Radars, one for each macro trend identified during the 3rd stage of the constant comparative method:

- Application of AI in the pre-diagnostic stage;
- Application of AI during diagnostics;
- Application of AI in post-diagnostics.

During the codification process, the author saw an emerging pattern where the majority of the interviewees' statements could be categorized to the different stages

of the diagnostic process based on the time and the type of interaction the interviewee anticipated with AI to happen.

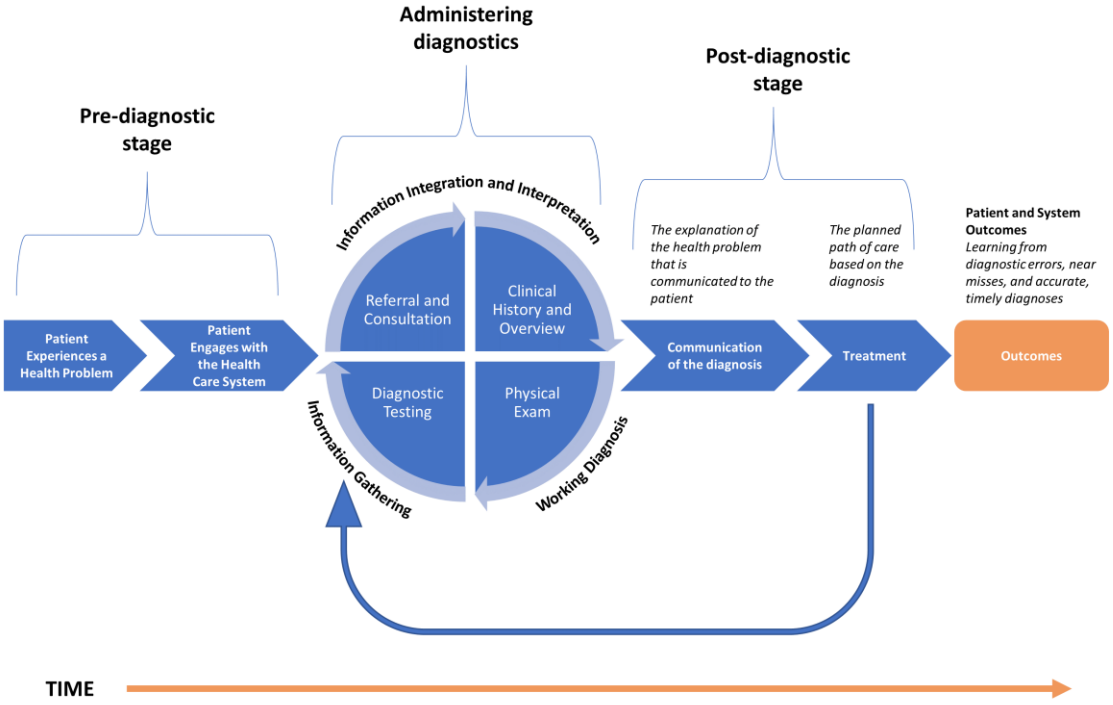


Figure 14. The Diagnostic Process (Adapted from Parasurman et. al. 2000; Sarter 2014)

There are several stages to the diagnostic process and the author referred to the classification of diagnostics formulated on the basis of the works of Parasurman et. al. (2000) and Sarter (2014).

The diagnostic process continues as follows; first, a patient is experiencing a health issue. The patient is probably the first person to consider their symptoms and may choose to engage with the healthcare system at this point. Once a patient is seeking medical care, there is an iterative process of gathering information, integrating, and interpreting information and determining a working diagnosis. Performing a clinical history and interview, a physical examination, diagnostic testing and referring or consulting with other clinicians are all ways to accumulate information that may be relevant to understanding a patient's health issue. The approaches to information-gathering can be used at different times, and diagnostic information can be obtained

in different orders. The ongoing process of gathering, integrating and interpreting information involves generating hypotheses and updating prior probabilities as more information is learned. Communication among healthcare professionals, the patient and the family members of the patient is critical in this cycle of gathering, integration and interpretation of information (ibid; ibid).

Working diagnosis can either be a list of potential diagnoses (a differential diagnosis) or a single potential diagnosis. Typically, clinicians will consider more than one diagnostic hypothesis or possibility as an explanation of the symptoms of the patient and will refine this list as further information is obtained during the diagnostic process. The diagnosis of the work should be shared with the patient including an explanation of the degree of uncertainty associated with a diagnosis of work. This information should be communicated to the patient each time there is a revision of the working diagnosis. As the diagnostic process proceeds, a fairly broad list of potential diagnoses may be narrowed into fewer potential options, a process referred to as diagnostic modification and refinement (Kassirer et al., 2010). As the list becomes narrowed to one or two possibilities, diagnostic refinement of the diagnosis of work becomes diagnostic verification in which the diagnosis of lead is checked for its adequacy in explaining the signs and symptoms, its coherence with the context of the patient (physiology, risk factors), and whether a single diagnosis is appropriate. The diagnostic verification step is particularly important when considering invasive or risky diagnostic testing or treatment options so that a patient is not exposed to those risks without a reasonable chance that the testing or treatment options will be informative and will likely improve patient outcomes.

It is important to note that clinicians do not need to obtain diagnostic certainty before initiating treatment. The objective of gathering information in the diagnostic process is to reduce diagnostic uncertainty sufficiently to make optimal decisions for subsequent care (Kassirer, 1989). Furthermore, the provision of treatment can also inform and refine a working diagnosis, which is indicated by the feedback loop from treatment into the diagnostic process' information-gathering step. This also illustrates the clinicians' need to diagnose health issues that may arise during treatment.

In line with the described diagnostic process, it became possible to match statements of the interviewees to the respective stage where a patient or a doctor could consult AI systems. The first stage happens when a patient self-evaluates his/her health, the next stage occurs when a patient is going through a series of diagnostics; the last stage is when patient and a doctor evaluate the patient's condition and decide on the course of treatment based on the results from the previous two stages. The choice for this trend identification based on the potential for AI application during the stages of diagnostics was then evaluated on the rest of the data set. After going through several interview transcripts, the researcher verified from the codification of the words of the interviewees' that this trend proposition was prevalent across the dataset and thus, the coding process began. After the full table of research findings was complete (see Appendix 1), the researcher moved to the construction of the Future Radars.

The design of the Future Radar was slightly modified from its original form developed by Saukkonen and Lundén (2018) in order to provide more space to illustrate an extensive number of established links between the consequences of the 1st and 2nd order across all three TOP-perspectives: Technological, Organisational and Personal.

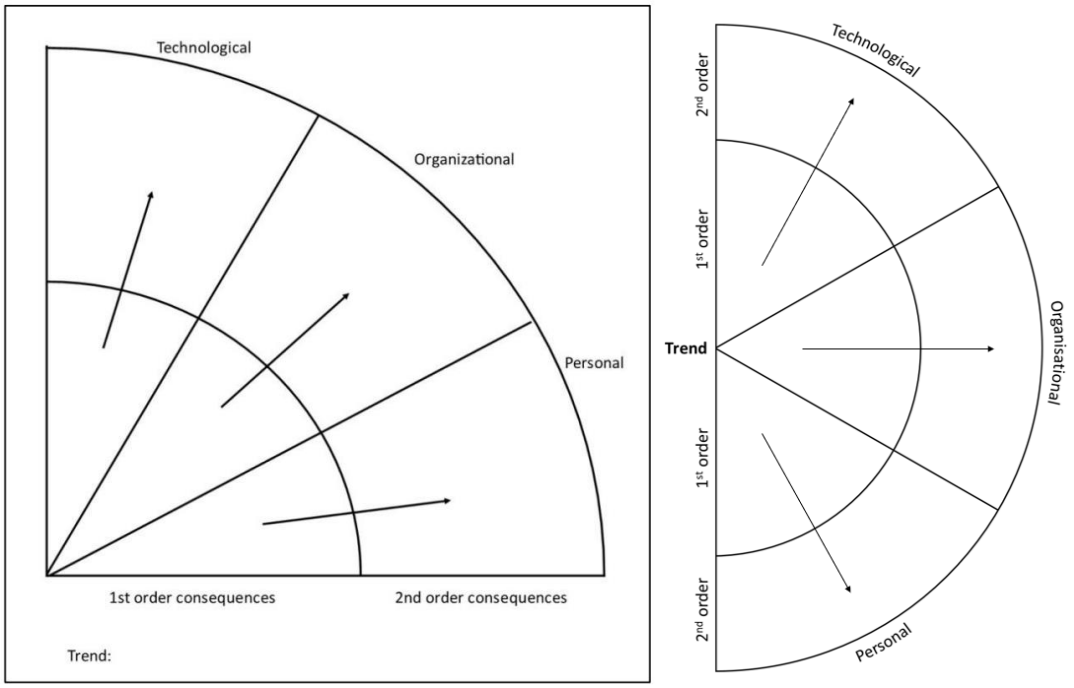


Figure 15. Comparison of visual representations of Future Radar (Adapted from Saukkonen & Lundén 2018). On the left – the original version, on the right – the version used in this study

It should be noted that the representation of the findings in the form of Future Radars implies that every single link between the consequences of the 1st and 2nd order should be treated as a potential version of future on its own. To illustrate this point further, sometimes different research participants can present polarising opinions on the future development of a single aspect. In such cases, the 1st order consequence may lead to branching alternatives in the 2nd order consequences which together are mutually exclusive in the future. For example, a consequence of the 1st order presented in the organizational perspective:

- The government regulates the openness level of the citizens' health data.

Linked 2nd order consequences within the same perspective:

- Domestic companies take advantage of creating new market offers;
- International companies dominate the healthcare market.

In contrast to these polarising consequences, should it be the case, a neutral standpoint can be adopted by one of the research participants which can be represented in the consequence of the 2nd order such as the following:

- Finnish citizens use products of both domestic and international companies.

Therefore, each link present in the radar represents a version of the future that could either exist on its own or potentially co-exist with other futures formulated by other links (when the factor of mutual exclusivity is taken into account). Such reading stance for the Future Radar as a tool furthermore reinforces its purpose to visualise multiple perspectives and expectations of the future by the chosen population sample in comparison to the scenario methodology when only several pre-determined by the researcher (based on the chosen axes) versions of the future are presented.

Not all consequences and links identified during the codification process are presented in the radars, firstly, because not every consequence of the 1st order was complemented by a linked consequence in the 2nd order. Secondly, the sheer quantity of the accumulated consequences was inapplicable to represent in the form of future radars. The radars feature the links and the consequences which were brought up by the majority of the research participants. The full research data set with all of the identified consequences and established links between them can be found in the Appendix section of this study (see Appendix 1).

Description of each radar starts with the explanation of the represented trend. It is followed by the commentary on the consequences arranged in three perspectives (technological, organisational and personal) which were initially derived and coded from the participants' answers. The radar description finishes with a summary of the displayed findings within the described trend. When referring to the consequences mentioned by specific interviewees, the participants' codes from the interview table will be mentioned at the end of the sentence as follows "Interviewees (following Int.) 4INV; 7INC; 8INC; 9SME; 13HCP/LAB". Refer to the interview table for the full list of the codes of the interviewees (see Table 2).

4.1 AI in the pre-diagnostic stage

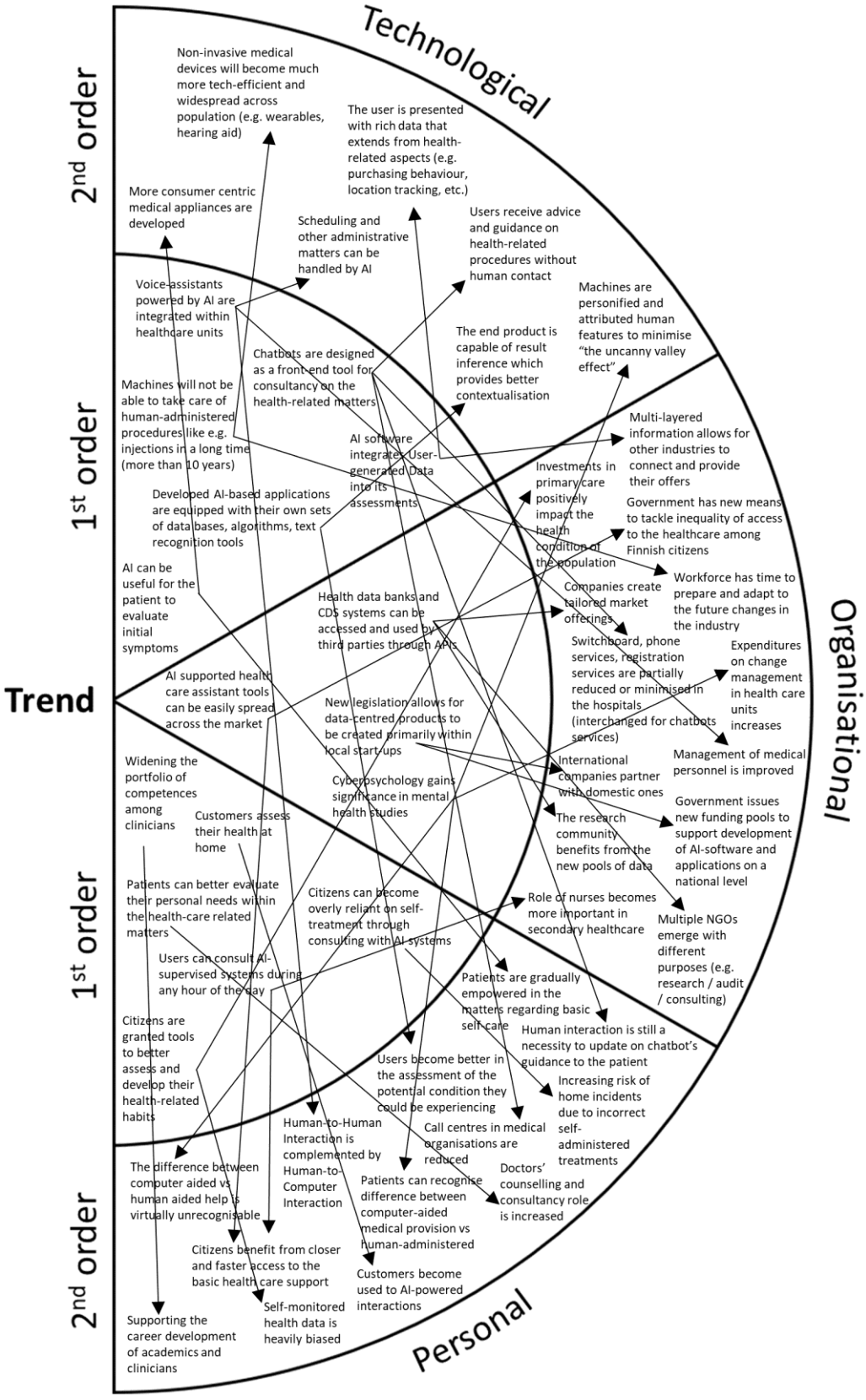


Figure 16. Future Radar (1) on the application of AI in the pre-diagnostic stage

Description of the trend

This radar focuses on the trend when the AI-supported technologies could be integrated within the pre-diagnostic stage when a person can potentially assess his/her health on his/her own. This could be achieved by consulting with the applications, tools, chatbots and other online or offline services that utilise machine learning to provide contextual results on the potential condition that the person could experience. This trend also demonstrates how the same technologies could be integrated within the healthcare units when the interactions of patients and personnel could be enhanced through the usage of voice assistants.

Technological perspective

From the technological perspective, participants of the research anticipate the integration of the AI-powered technologies in handheld consumer devices such as phones or tablets in the form of applications. These apps are expected to support data exchange between home health care devices such as different kinds of meters/monitors (e.g. thermometers, blood glucose meters) as well as various assistive technology (e.g. hearing aid) and wearables (e.g. fitness bracelets). The data inputs and outputs will be shared between the devices (the devices are interconnected within the same Internet of Things network) and will be transmitted to the mentioned applications. The received information will be further processed and analysed through app's integrated set of databases and algorithms to present the user with an informed set of factors that constitute his/her current health condition on the time of monitoring (Int. 2INC; 3HCP/LAB; 6PRO/ASSOC; 9SME). Apart from analysing data from the medical devices, these applications may also take into account user-generated data from his/her social networks and/or information about location tracking and/or statistics about online purchasing behaviour to provide better contextualisation for the end results (Int. 2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB). For example, a user can self-diagnose that he or she is experiencing cough and through the app, he/she can identify whether the cough is dry or wet and if any severe symptoms are present. Based on this interaction, the app can then suggest a visit to the nearest

medical unit or it will offer a link to purchase a cough mixture either in the closest pharmacy or in the last time visited online pharmacy store.

In addition, chatbots powered by AI are expected to gain more widespread usage across the population. Users will consult chatbot services to receive guidance on the health-related matters as well as to schedule their next appointment with the doctor, should they be in need for it. Thus, this technology can potentially substitute phone assistance services commonly present in the hospitals across the country (Int. 1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 10HCP/LAB). The participants of the research expect voice-enabled assistants to be also integrated within healthcare units as a tool to guide patients within the facility as well as to assist medical personnel in their administrative tasks. The challenge in integrating voice chatbots lies in the factor of the human likeness of a computer-generated voice. The effect of "uncanny valley" is seen as a potential threat emerging from the technologies that attempt at substituting human-to-human interaction (Int. 1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 9SME).

Despite mentioned anticipated technological advancements, majority of interviewees share the opinion that a wide range of AI-powered machinery will not be able to conduct any of the common human-administered procedures usually found in the stage of pre-diagnosis like, for instance, taking blood samples to test blood sugar at home. The participants agree on the fact that it would take more than 10 years to see any robotic medical devices appearing in private homes (Int. 6PRO/ASSOC; 10HCP/LAB; 12 POL/SME; 13HCP/LAB).

Organisational perspective

The presented trend bears a multitude of organisational consequences to different businesses and enterprises operating in the country. The participants propose that the AI-supported health care assistant tools could be easily spread across the market through digital distribution platforms (e.g. Google Play, App Store) which will positively impact the citizens' level of access to the basic healthcare services across the country (Int. 1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 12POL/SME;

13HCP/LAB). At the same time, health-related information stored on the users' devices can be potentially accessed and shared through APIs which would allow third parties to connect and create better, more targeted, personalised market offerings. This could potentially also be relevant to the companies operating outside of the healthcare industry that can curate their services and products based on the customers' health data (e.g. travel agencies suggesting tours to thermal resorts as a medical tourism package) (Int. 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 12POL/SME).

On the premise of new information repositories emerging in the healthcare industry, several interviewees anticipate that the network of operating non-governmental/non-profit organisations in the country will increase. These newly formed associations will address a variety of purposes ranging from audit companies focusing on the protection of consumer rights to scientific research accelerators aiming at tackling rare diseases (Int. 6PRO/ASSOC; 8INC; 10HCP/LAB; 12POL/SME; 13HCP/LAB). Domestic businesses also have the potential to profit from the new untapped market of consumer health data should the government provide favourable conditions for this to happen. This can be achieved by issuing new legislative bills aimed at formulating consumer-company relationships within this forming industry segment as well as by creating new domestic funding pools to foster AI software development in the country (Int. 1INC; 6PRO/ASSOC; 11INC; 13HCP/LAB).

With new AI technologies becoming available to broader customer audiences, traditional healthcare units are poised to experience major shifts in their conventional ways of operations. Switchboards, registration desks, customer support and other phone services could be potentially scaled-down and replaced for cheaper alternatives in the form of voice assistants and chatbots (Int. 1INC; 5SME; 6PRO/ASSOC; 7INC; 8INC; 13HCP/LAB). This may outline the need for repurposing the personnel previously responsible for the mentioned services to other departments or service areas within the healthcare organisation. A few participants pointed out the potential shift in the role of nurses towards secondary healthcare when machines would be able to substitute initial consultancy and check-ups

traditionally conducted by assistance health care personnel (Int. 1INC; 3HCP/LAB; 13HCP/LAB). However, this perspective was not shared by the majority of the sample. In turn, most of the interviewees agreed on the increasing influence of cyberpsychology studies in the new operational environment. It is perceived that administrations of the healthcare units across the country will be pressured to invest in training of the personnel associated with change management as well as in practices associated with developing field of psychological interactions happening inside the technology-facilitated media (Int. 2INC; 3HCP/LAB; 5SME; 7INC; 8INC; 9SME; 10HCP/LAB; 11INC).

Personal perspective

The consequences which formed the personal perspective of this trend can be divided into two main vectors of influence – influence on the users/customers/patients and influence on the clinicians/doctors/medical personnel. When it comes to the medical personnel, research participants pointed out the need for doctors to improve their technological competences and be prepared to interact with patients through new AI-integrated systems. This calls for educational and career development of current and future medical employees to provide them with necessary skills to maintain quality and efficiency in the provision of healthcare (Int. 2INC; 4INC; 7INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB). This is also justified in the opinions of the interviewees by an assumption that human interaction will still be necessary to provide guidance and assistance to the patient after he/she consulted with a chatbot or other self-diagnostic systems.

Users become empowered in the matters regarding their health care management with the provision of new technologies. Some clinicians that took part in the study shared that they have already experienced the need to adopt a new mindset over “patients” to “customers” to the people that they were treating (Int. 3HCP/LAB; 10HCP/LAB). This empowerment comes from such factors as constant availability of AI-supervised systems during any hour of the day as well as a broad assortment of tools and applications that provides users with medical reasoning previously hardly accessible to them. Nevertheless, the shift in consumer habits also comes with

potential challenges and threats, for instance, an unprecedented bias when assessing one's health condition without professional expertise (Int. 2INC; 3HCP/LAB; 5SME; 8INC; 10HCP/LAB; 11INC). In extreme cases, the consumers may reject professional help altogether and become self-reliant on preventing and managing experienced health issues. Some of the research participants even highlighted an increased risk of home incidents due to incorrect self-administered treatments (Int. 2INC; 5SME; 6PRO/ASSOC; 7INC; 8INC).

Review of the trend anticipation

To sum this radar, the integration of AI-supported technologies in the pre-diagnostic stage is anticipated as an industry-changer when the conventional roles of patient and doctor can be significantly altered. For the end consumer, this shift can be very beneficial as users may become much more aware of their healthcare management. The doctors, on the other hand, need to be ready to deal with more competent patients looking for medical support. The industry is expected to undergo through cardinal shifts which if managed correctly can provide beneficial opportunities for the involved stakeholders. More or less, this trend is perceived by interviewees as inevitable with signs of development already present in the time of this work's publishing. The industry representatives come to an almost unanimous opinion that healthcare providers can minimize potential drawbacks of future changes associated with this trend by focusing on the digitalisation of their current operations in advance.

4.2 AI as part of the diagnostic process

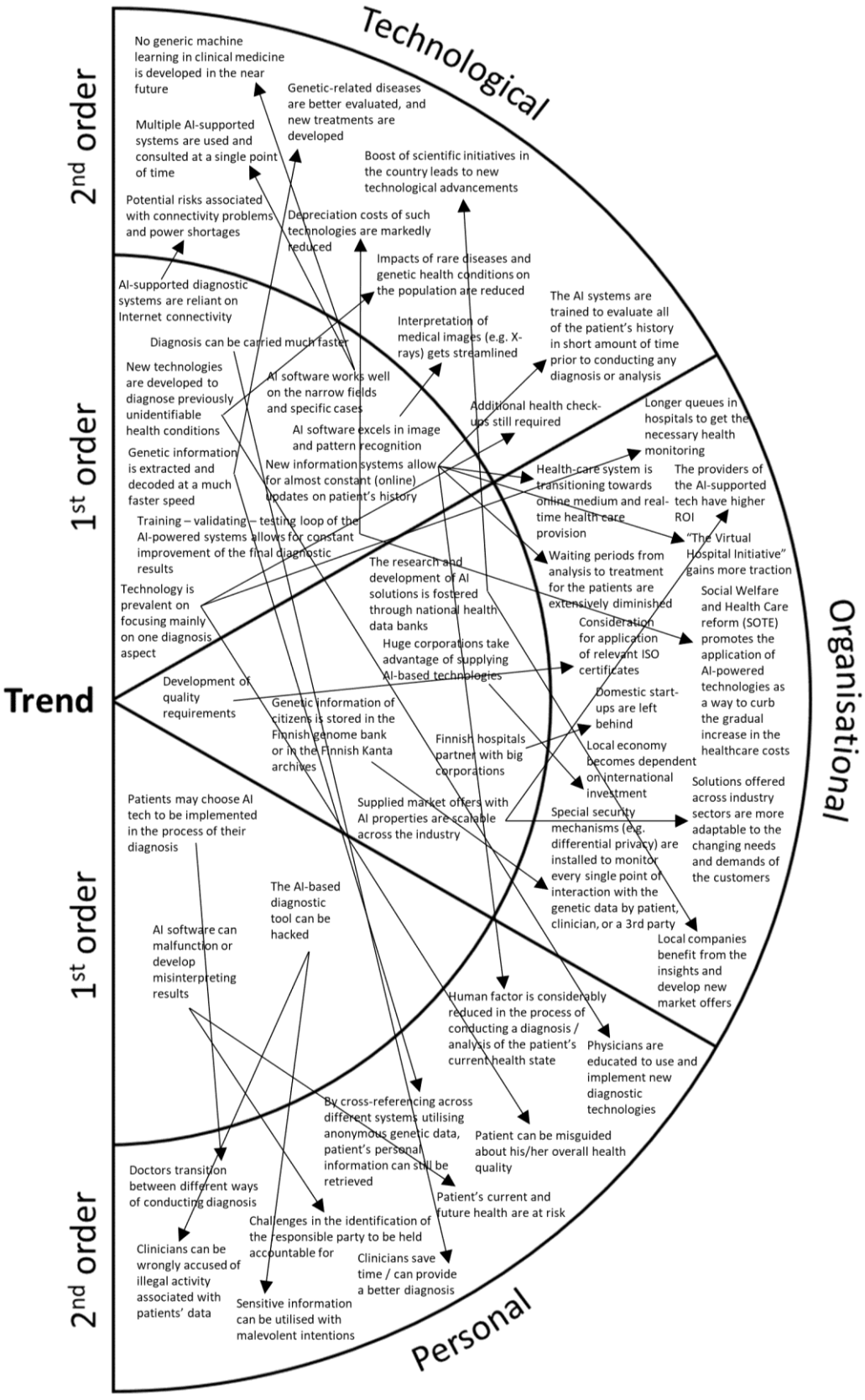


Figure 17. Future Radar (2) on the application of AI during diagnostics

Description of the trend

The second radar represents the trend when AI technologies are applied in the diagnostic stage when the health condition of the patient is evaluated and analysed through various means of clinical tests such as medical imaging, electrocardiography and else. During this stage, clinicians interact with AI-supported systems to conduct necessary measurements required to make a further judgement on what the patient diagnosis could potentially be. The radar also reflects the participants' opinions on the storage and usage of citizens' sensitive health information, for instance, genetic, that is retrieved during the diagnostic stage.

Technological perspective

Participants see a lot of potential in the application of AI technologies in the field of medical imagining when computer vision and machine learning are implemented to discern potential anomalies found in the patient's organs. The systems are trained to recognise differences between healthy and unhealthy images by referring to respective image datasets. Through the accumulation of identified results, the systems become better at assessing the state of a patient's internal or in certain cases, external organs. The training-validating-testing loop of the AI allows for constant improvement of the final diagnostic results which can be further applied and enhanced with every next patient case (Int. 2INC; 3HCP/LAB; 5SME; 7INC; 9SME; 10HCP/LAB; 11INC; 13HCP/LAB). Nevertheless, such method of analysis only excels at very specific diagnostic cases and it is improbable to make assessments of the patient's overall health condition based solely on the interpretation of e.g. his/her X-ray images or electrocardiogram. Multiple screenings and monitorings are necessary, thus multiple machine-learning systems need to be trained for each specific purpose (Int. 2INC; 6PRO/ASSOC; 7INC; 8INC; 13HCP/LAB).

Even though no generic machine learning or an alternative technological "single fit solution" is foreseen to be developed in the near future to make assessments of the patient's health on multiple levels, it is not seen as a drawback by the interviewees. On the contrary, some of the research participants propose that the development of

separate machine-learning systems for each specific diagnostic case or each specific analysis method may be a more viable option from both businesses as well as a research perspective. Such an approach could potentially allow trained systems to recognise previously unidentifiable or very rare diseases and health conditions (Int. 1INC; 5SME; 6PRO/ASSOC; 8INC). At the same time, depreciation costs of such technologies should be markedly reduced as the upkeep of AI diagnostic tools will not be limited to the change of hardware, but will rather rely on the constant software updates (Int. 1INC; 3HCP/LAB; 5SME; 9SME).

The anticipated constant or continuous operational aspect of the future network of technologies can also improve the process of patient's monitoring, especially when taking into account the increasing adoption of different kinds of wearables. Some interviewees suggest that patient history as a term may be replaced by "patient medical outlook" which will reflect not just patient's past medical history, but also his/her health condition monitored in the real-time and potentially even prospective future conditions (Int. 2INC; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 11INC; 13HCP/LAB). In some regards, all of this information will be taken into account to suggest doctors the most appropriate diagnostic and analysis procedures that are relevant for the patient at a certain point of time. Still, the continuity of such AI operations is reliant on two crucial factors such as power supply and Internet connectivity. In cases where these factors are undermined, clinicians may experience abrupt technological problems, for instance, intermissions, which will negatively impact the overall quality of the administered analysis (Int. 1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC).

Organisational perspective

Evolution of the public's perception of conventional methods of healthcare provision pressures hospitals and other medical units across the country to reevaluate their value and supply chains. Some interviewees emphasize the transition towards online medium and the establishment of "Virtual Hospitals" (Virtuaalisairaala, fin.) when patients can be serviced in real-time (Int. 3HCP/LAB; 5SME; 8INC; 12POL/SME; 13HCP/LAB). The increasing availability of digital healthcare services to the end

consumer may have an impact on hospital operations carried in real life. In this aspect, the research participants shared contrasting opinions depending on how the patient flow in the medical units will be managed. On the one hand, the select number of participants expect longer queues in hospitals for patients to get the monitoring or diagnosis they require (Int. 4INV; 7INC; 10HCP/LAB; 12POL/SME; 13HCP/LAB) while on the other hand, a few interviewees hope to see waiting periods minimised or possibly happening outside of hospitals (Int. 1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 11 INC).

The new practices of conducting diagnostics using AI-powered software need to be properly certified if not on international, then on the governmental level. Should these practices become an industry standard, then the application of a new ISO certificate(s) is expected, for example, in a form of a potential addition to ISO/IEC 17025 standard. Its new revision could indicate the integration of AI software across testing and calibration laboratories (Int. 2INC; 4INV; 10HCP/LAB). A proper level of quality assurance is also expected when it comes to the storage of genetic information. Citizens will be able to store their genetic information and other sensitive health data in patient data repositories of Finnish digital Kanta services. Special security mechanisms will be developed to track every single point of interaction happening with this information inside Kanta services whether by a patient, clinician or a 3rd party, e.g. research group (Int. 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 13HCP/LAB).

The application of AI suite of technologies in the stage of conducting diagnosis is perceived to have huge business potential, mostly due to their scalability. The ability of the AI-powered solutions to improve performance and efficiency with larger operational demands is significantly emphasized by the participants. This allows for developers to receive an increased return on investment as well as to provide solutions better fit to the changing needs and demands of their customers (Int. 5SME; 7INC; 8INC; 9SME; 11INC). However, the market for AI-enabled software is expected to get saturated relatively fast and it is seen as a major concern among the interviewees. Should it be the case that international corporations become the first ones to provide their innovative offerings to Finnish hospitals, domestic companies

will not be able to successfully penetrate the local market. This could potentially lead to local economy becoming dependant on the international investment (Int. 4INV; 5SME; 7INC). Nevertheless, an alternative version of the future could be where Social Welfare and Health Care reform (SOTE) promotes the application of AI-powered technologies developed by local companies as a way to curb the gradual increase in the healthcare costs (Int. 3HCP/LAB; 10HCP/LAB; 12POL/SME; 13HCP/LAB).

Personal perspective

On a personal level, the consequences of this trend are both positive and negative. The interviewees often referred to the word “ambiguity” when describing potential implications associated with the widespread integration and adoption of AI-based technologies in the area of medical diagnostics. From the positive side, the human factor could potentially be considerably reduced when analysing the current health state of a specific patient. This is achieved through the application of superior to human-computer vision properties in the identification of certain conditions as well as in conducting a more rigorous analysis on the patient’s history by AI generating results through multiple inferences with different information systems (2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 1OHCP/LAB). Patients are presumed to be given a choice to opt for AI diagnostic tools when evaluating their health condition which can potentially provide them with more focused and detailed results. Physicians, in turn, are trained to use new technologies and to transition between different ways of operating diagnostic procedures (Int. 1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 1OHCP/LAB; 13HCP/LAB).

The ambiguous reception of this trend is represented in the consequences associated with the aspect of responsibility. Despite potentially minimising the human error in the evaluation and assessments, the conditions for technical errors will still be present. AI software could malfunction or produce misinterpreting results which will put patient’s current and future health at risk due to incorrect analysis outcomes (Int. 1INC; 2INC; 3HCP/LAB; 6PRO/ASSOC; 12POL/SME; 13HCP/LAB). If such a situation happens, the responsible party is challenging to identify. It could be the developer behind the utilised AI systems; it could be the doctor administering the

diagnostics who was not able to recognise that the final results are misguided; it could be the accreditation body that certified the installation of the AI-supported diagnostic tools within the medical unit and else (Int. 1INC; 2INC; 5SME; 6PRO/ASSOC; 7INC; 8INC; 1OHCP/LAB; 13HCP/LAB). Some interviewees also formulated an example when none of the mentioned parties could be held responsible – AI like any other digital systems may be hacked. This brings major challenges in the legal side of the issue. In line with this reasoning, a few participants mentioned potential instances where clinicians may be wrongly accused of illegal activities associated with manipulating of patient's health data (Int. 5SME; 6PRO/ASSOC; 12POL/SME).

The anonymity of citizens' confidential health data is also put under question by the interviewees. By cross-referencing across different systems utilising anonymous genetic data, patient's personal information can still be retrieved, for example, through implementing facial recognition from face-to-DNA classifiers (Int. 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB).

Review of the trend anticipation

In conclusion, utilisation of AI in the diagnostic process can provide much better efficiency in the operations of healthcare units across the country. Provided that medical conditions are identified much faster and more precise, clinicians can save time and resources required for the actual treatment. Consequently, research participants anticipate changes in the management of the patient flow. Customers begin to transition between offline medical facilities and online virtual hospitals depending on their personal needs. However, there is a variety of stopping factors that could prevent the full realisation of this trends' potential. These include security and quality concerns, the controversy surrounding patients' privacy and exposure of the domestic market to the international investment.

4.3 AI in the post-diagnostic stage

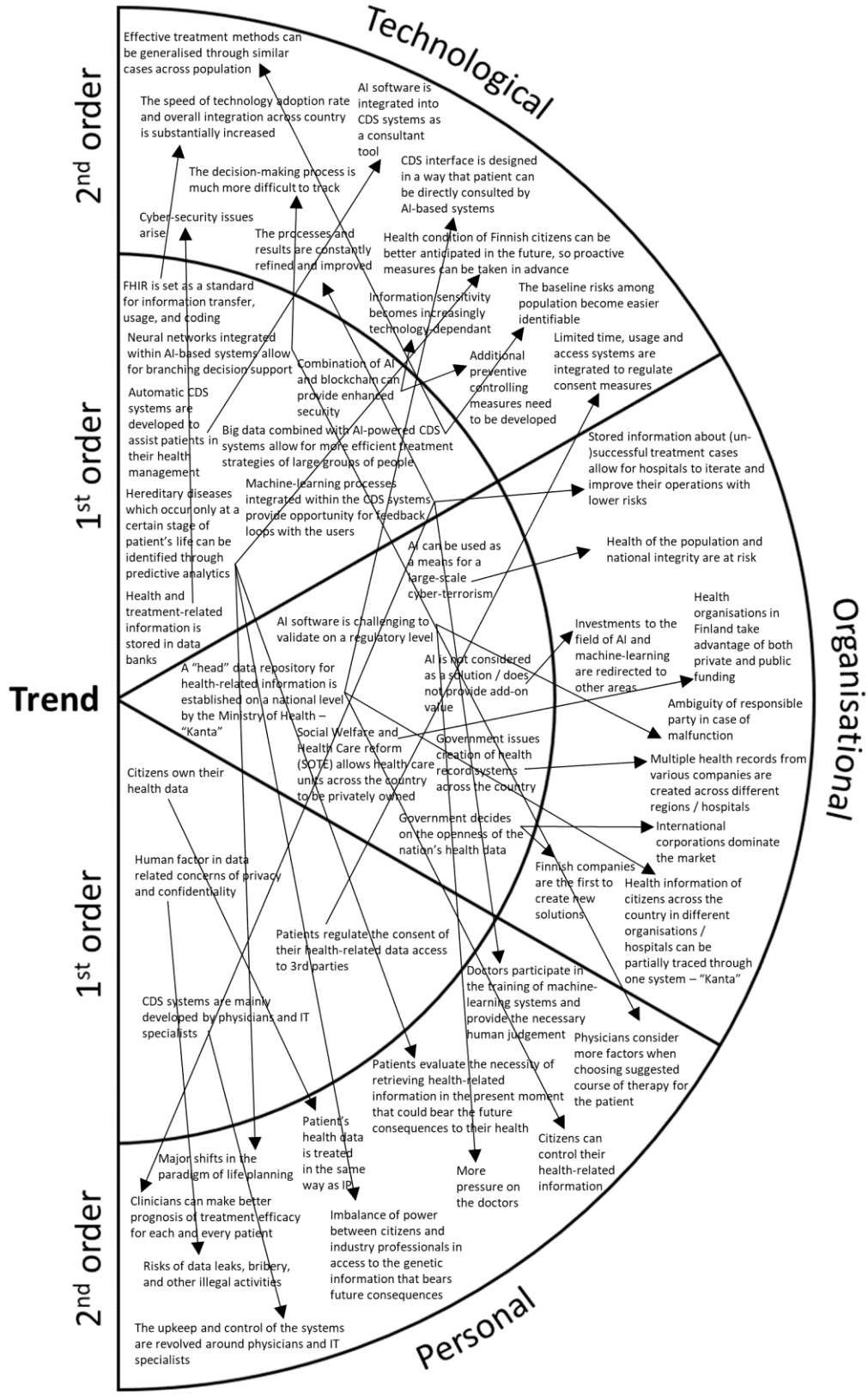


Figure 18. Future Radar (3) on the application of AI in the post-diagnostic stage

Description of the trend

The trend of utilising Artificial Intelligence in the post-diagnostic stage of patient's customer journey is represented in the final radar. It encompasses the interactions of doctors and patients with the Clinical Decision Support (CDS) systems in order to determine the appropriate course of therapy or treatment. Furthermore, the consequences associated with the establishment of multiple health records to deposit health data of Finnish citizens are represented in this radar.

Technological perspective

The utilisation of AI suite of technologies in the post-diagnostic stage is mostly revolved around their integration within CDS systems, development of which is seen as a cornerstone of technological integrity in the field of Finnish healthcare by the interviewees. Physicians use these systems to inform their clinical decision-making, for example, to contextualise the reasoning behind suggesting a particular course of treatment to the patient. CDS complemented by AI capabilities have a potential to provide extensive consultancy on the facilitation of medical procedures to the doctors which can be particularly useful when the human judgement alone does not prove to be reliable enough (Int. 1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 9SME). A particular example that illustrates this point was brought up by the interviewee 3HCP/LAB: "When I am choosing which drug to prescribe to the patient, I ought to evaluate a potential impact of every side effect that a chosen drug could inflict on the patient. CDS systems that utilise machine learning can be very helpful in this regards to estimate the probability of all possible side effects which I will refer to when finalising the prescription". Notably, "Fast Healthcare Interoperability Resources" (FHIR) is set to be an operating standard to support the infrastructure of Clinical Decision Support systems and associated AI-software (Int. 2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 9SME).

Applications of machine learning, neural networks and Big data in the healthcare may introduce multiple new opportunities for people operating in the field. Clinicians will be able to constantly refine their treatment strategies by improving on the

suggestions presented by the AI systems. The previously mentioned training-testing-validating loop is applicable in this context, however, this time it is a combination of human judgement and machine learning that will produce constantly improving results (Int. 1INC; 3HCP/LAB; 6PRO/ASSOC; 10HCP/LAB; 12POL/SME). After a certain time of refining processes on the analysed patient cases, the improved methods and techniques of health evaluation and treatment planning would allow for a certain extent of generalisation. A generalisation of results which are informed with Big data will lead to easier identification of baseline health risks associated with certain drug intake and therapy types among the population (Int. 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC). Neural networks which constitute the essential element of AI reasoning allow the system to come up with branching, alternative suggestions to the physician related to the implementation of each specific treatment plan. However, the same technological feature makes it much more difficult to track the computer logic which led to suggesting those branching alternatives in the first place. Stemming from the fact that clinicians are not expected to take computer-generated suggestions for granted, they will need to discern every single computation made by the systems they consult (Int. 2INC; 6PRO/ASSOC; 10HCP/LAB; 11INC).

Potential for predictive measurements and future assessments is likewise presented by the integration of AI technologies. In the same manner, as AI may estimate the side effects of a certain type of drug, it can imply similar processing to identify any preconditions of the patient to hereditary diseases and estimate potential timeframe in the future when he/she could experience them (Int. 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB). Identification of such sensitive information calls for profound security measures to validate the anonymity of uncovered data. Majority of research participants propose the usage of cryptographical solutions such as permissioned (private) blockchains to safeguard citizens' genetic data (Int. 1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 7INC; 8INC; 9SME; 11INC). However, a select few interviewees regard this solution as counter-productive because in their opinion the whole security system becomes increasingly technology dependant and so, they necessitate the development of additional preventive and controlling security measures (Int. 6PRO/ASSOC; 10HCP/LAB; 12POL/SME; 13HCP/LAB).

Organisational perspective

Before arriving at the post-diagnosis stage, patients have already accumulated a large volume of data through their previous interactions with the healthcare system and this volume continues to increase with every new touchpoint. Interviewees accentuate the value of this data which can be used to enhance the provision of medical services plus to reduce potential risks to patients, staff, visitors and organisational assets. However, it is only possible on the condition that patients provide their consent for their customer-related information to be handled in such a way. Due to the fact that the healthcare organisations can gain and save a lot of financial resources by utilising this information, participants anticipate that future operations in healthcare and similarly in other industries will be enacted mostly on the basis of data consent (Int. 1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 13HCP/LAB).

The health-related information of citizens which extends from the physiological characteristics to the patient history is assumed to be stored in health data banks and other forms of information repositories. Interviewees foresee that multiple health data archives will be present in the country with every hospital potentially having its privately-owned information system (Int. 3HCP/LAB; 6PRO/ASSOC; 8INC). Notwithstanding this possibility, digital healthcare “Kanta” services are expected to be the most widespread. Governmental provision and support of the national health data banks within the “Kanta” services incentivises citizens to use this complex system to regulate their interactions happening within the healthcare industry (Int. 1INC; 2INC; 5SME; 6PRO/ASSOC; 7INC; 11INC).

Government regulations considering the electronic processing of citizens’ data in social and health care services so far have been limited to the scope of the country, as noted by some interviewees (Int. 1INC; 2INC; 4INV; 11INC). They also mention that the situation could change in the future when the Finnish government may decide to open access to the nation’s health data to the international bodies for example, for scientific purposes. Depending on the legalities of this decision, research participants can envision possibilities for the Finnish companies to connect with international

healthcare market and export domestic services (Int. 4INV; 10HCP/LAB) or in other case, possibilities for foreign corporations to impose their business solutions on the local market (Int. 2INC; 5SME; 9SME).

Perception surrounding the adoption of the AI technologies in the post-diagnostic stage where it can serve as a mean to enhance the provision of digital healthcare services or as a consultancy tool for doctors and patients to verify consecutive treatment plan is not seen as substantial to justify potential challenges associated with its development (Int. 3HCP/LAB; 4INV; 5SME; 8INC; 12POL/SME). Interviewees acknowledge that financial, legal and technological factors have an impact on stakeholder decisions who need to weigh out the pros and cons of AI integration. Challenges of validation on a regulatory level (Int. 3HCP/LAB; 4INV; 9SME; 13HCP/LAB), potential threats of large scale cyber-terrorism and hacker attacks (Int. 2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 12POL/SME), little add-on value in the trial testing periods (Int. 3HCP/LAB; 4INV; 5SME; 8INC; 12POL/SME) are among of the factors that dwindle participants hopes and expectations of AI inclusion in the post-diagnostic stage.

Personal perspective

The interviewees expressed their ethical concerns and moral dilemmas associated with foreseen technological development in the healthcare sector which formed the majority of consequences of 1st and 2nd order presented in the personal segment of the radar. After analysing the participant's statements, three prominent topics were distinguished; handling of Clinical Decision Support systems, protection of personal medical information and future of individual life management.

Clinicians and Information Technology specialists are assumed to be responsible for the management of CDS infrastructure, however, the role of the former is viewed more significant than of the latter. Even though IT coders and engineers may be the party responsible for the upkeep and development of AI software used in CDS, they are not the ones who will train the machine learning algorithms – clinicians will. Medical personnel is counted open to provide the human judgement necessary in

rationalising the AI algorithms based on cross-referencing between the patients' health data and the medical records (Int. 1INC; 2INC; 6PRO/ASSOC; 7INC; 8INC; 11INC; 13HCP/LAB). Overall, the provision of new technologies and linked advancements in the healthcare operations put more pressure on the doctors to "keep up" with the increasing speed of development happening in the industry (Int. 2INC; 4INV; 5SME; 7INC; 8INC; 11INC; 13HCP/LAB).

The privacy of personal medical information is unquestionable, yet there is no uniform approach to how it should be protected. Most research participants would like to see the conditions under which the citizens will have full ownership of their health data and customer-related information garnered through the interactions inside the medical units (1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB). Some see this possibility coming to fruition if the data would be treated in the same way as intellectual property (Int. 1INC; 3HCP/LAB; 4INV). Hence, the customer-company interactions may transition from essentially consent-based to potentially fee-based when citizens charge parties interested in access to their health data.

A premise of predictive analytics adopted in the post-diagnostic stage may open possibilities for patients to uncover future insights about their health. Patients will need to make a moral decision where they inquire to be informed of factors that could potentially have an impact on their health condition in the upcoming years from the moment of diagnostics (Int. 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC). Some interviewees point out that doctors should also not be aware of these factors if the patients that they are treating decide not to use this information in their health management. Otherwise, the doctors would be much more informed about the patients' state of health from the results presented in the AI-supported CDS systems which leads to an imbalance of power between citizens and industry professionals in access to the sensitive health information (Int. 1INC; 3HCP/LAB; 6PRO/ASSOC; 11INC). Besides, such data, regardless of its usefulness to the end consumer and the clinicians, can be "weaponised" if used for malevolent purposes; bribery, blackmailing and else (Int. 3HCP/LAB; 4INV; 7INC; 9SME; 12POL/SME).

Review of the trend anticipation

Radar representation of the trend of AI integration in the post-diagnostic stage reflects its mixed reception among the research participants. Most of the opportunities for the technology to be utilised were seen in the conjoint operation with Clinical Decision Support systems. Interviewees in their statements brought up a number of anticipated challenges that correlate to the development of AI software purposed for the consultancy of clinicians on the patients' health management. These conceived "red flags" are featured in all three perspectives; concerns over technological dependency; organisational obstacles for AI adoption; personal judgments on health information sensitivity. Participants do not deny the future ground for AI usefulness in the healthcare operations within this stage, however, the majority agrees that it will take a lot of time before stakeholders would come to a conclusion on how to make AI technologies viable.

5 Discussion

This section of the thesis is focused on evaluating the core purpose of this study, followed by an overview of the research findings in regards to providing an answer to the research question. It provides the outcomes of the primary data analysis in the light of secondary data. Besides, this section states the practical application of this research and the main product of the research – Future Radars.

5.1 Answer to the research question

The main objective of the study was to ascertain the most prospective directions for the development of AI technologies in Finnish primary care. As the result of the data analysis and the representation of the findings in the form of Future Radars, it can be stated that there are three major trends associated with the development of AI in primary care – application in the pre-diagnostic stage, during diagnostics and in the post-diagnostic stage.

The answer to the research question is complemented with the composition of the scenario framework that was based on the formulated research objectives:

• To ascertain the projected directions of development of AI-based solutions.

• To evaluate potential benefits and concerns and challenges arising from AI implementation.

• To identify the key factors that would influence the development of AI technologies in Finnish primary care.

5.1.1 Author's reflections on the research findings

Analysis of the research findings through the Multiple Perspectives methodology and their following representation in the form of Future Radars proved to be an effective tool for the visualisation of sample's perspectives grouped into three identified macro trends on the topic of prospective AI application in the Finnish primary care. However, the chosen framework may not be an optimal solution for a reader to form his/her judgements on the potential futures that these trends could lead to based on several reasons.

First, the consequences in the radars are not differentiated between each other on their future plausibility (e.g. possible against probable) and their perceived scale of impact (e.g. minor, medium, major) across three discussed areas; technological, organisational and personal. It is assumed that all of the presented consequences share the same likelihood of realisation and similar scale of impact, although, this assumption is false when reviewed on the original data set of interview transcripts. In the course of the interviews, the research participants shared their assumptions on these aspects which were conveyed in their statements. In the process of analysing the statements and their further codification based on similarities across the dataset, these personal attitudes were left out in favour of presenting the overall

disposition on a certain topic shared between two and more interviewees. For a reader to capture an essence of those attitudes which did not make into the final analysis, it would require to read the data set transcripts or to listen to the original audio recordings, as some of the sound cues could also present additional context of the interviewees' opinions.

Secondly, the presentation of findings in a form of radars does not pursue a goal of their generalisation which some readers may find misleading. On the contrary, every single consequence derived from the dataset could have an impact on the future on its own accord, thus the opinion of each of the interviewee holds value to the richness of the overall data set. In line with this reasoning, the author attempted to present all of the extracted consequences in one full table. However, due to the sheer amount of generated consequences, it was improbable to present them all in the radars. Thus, if the reader wants to familiarize him/herself with the full scope of the research, the full table presented in the Appendix section (Appendix 1) of the report needs to be taken into account.

Thirdly, described perspectives within the radar do not usually fall in line within the same time horizon which makes it challenging to estimate the future timeframe when a particular trend consequence could occur. In particular instances, the interviewees shared their opinions on when a certain event might happen by specifying a year or a period and this was reflected in the consequences of a certain perspective. As a matter of fact, technological changes were anticipated to take place earlier in the future than organisational or personal. Nevertheless, there were a few exceptions when interviewees suggested that some personal or organisational actions can be executed in anticipation of a certain technology. Such variability of presented consequences that could all exist in a different timeframe makes it complicated for a reader to ascertain personal projections on the analyzed trends and topics within those trends.

In an attempt to counter the mentioned limitations of the radars, the author proposes his perspective on how to approach the reading of the research findings through potential scenarios that are based on the author's reflections.

5.1.2 Suggested Scenarios

During the process of analysing the research findings, the author discovered cases where interviewees presented conflicting opinions on the potential realization of certain consequences. In such cases, the realization of the consequence was dependant on a certain factor where in the opinion of interviewees its development could lead to a pre-determined future scenario. Presence of the conflicting cases led the researcher to identify several driving forces the influence of which could bear an impact on how the trends of AI integration in Finnish primary care may come in effect. Two major forces that were deliberated by every single interviewee were involvement of the state and technological change.

State or governmental involvement refers to the level of control from the country's administrative bodies on the processes happening inside the healthcare industry. It includes legislative, financing, social and other actions. The research participants estimated that the driving force of governmental involvement is the one controlled by citizens, thus a certain future trend can to some extent be manipulated to effectuate in a desired way inside the country. State of governmental involvement is usually measured in terms of its scale.

Technological change encompasses the invention and development of new technologies and processes, their following commercialization and the diffusion of technologies within the industry or society. It is a social process that is heavily influenced by adopters and developers of new technologies and by associated organisations that they are part of. Therefore, the speed of technological change can be influenced by social actors. However, this factor's impact on the Finnish primary healthcare is not fully under the control of the citizens. Interviewees agree on the notion that Finland as a state is not a self-sustained system. By playing an active role in the international agenda, the country is subject to an outside exposure from

international corporations, research institutions, intergovernmental organizations to name a few that could all have an impact on the technological change happening in the country. As a process, the factor of technological change is generally evaluated in terms of its speed/rate of development.

When juxtaposed against each other, these factors can present a feasible framework that could be used to draft conceivable scenarios formed upon interviewees' conflicting speculations.

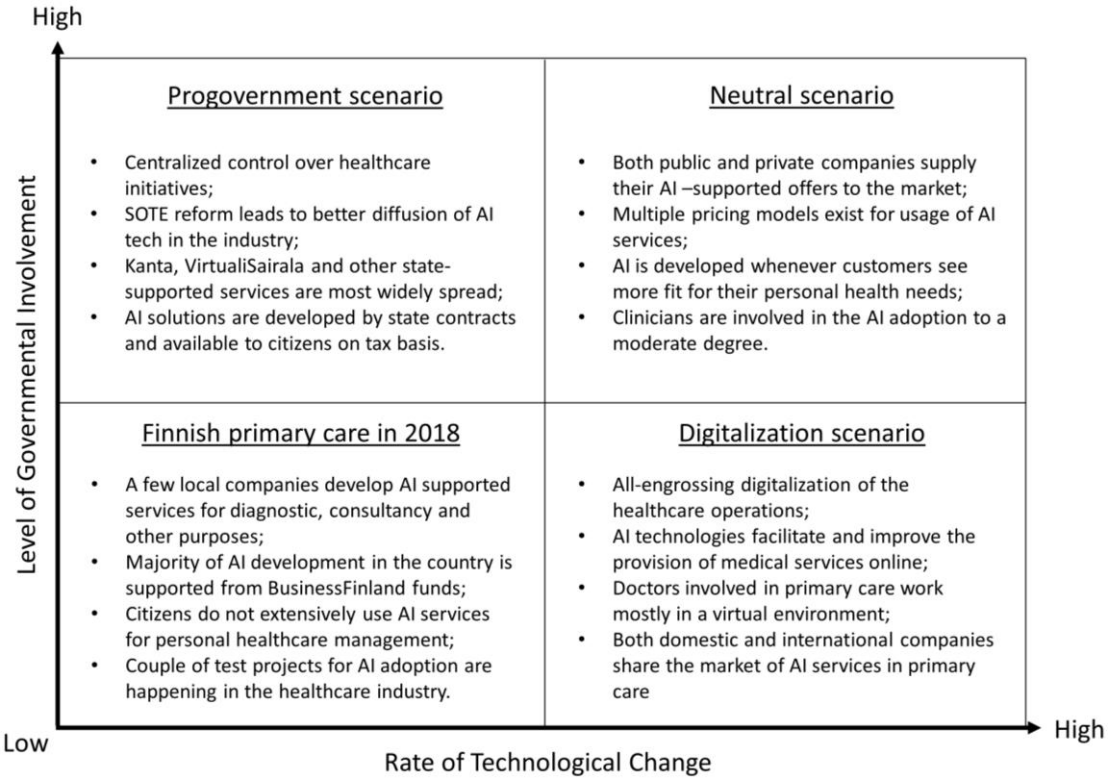


Figure 19. Suggested scenarios from the research findings

The author decided to implement a scenario framework to showcase the perceived scenarios emerging from the final analysis of the research findings. In contrast to the future radars and Multiple Perspectives used to demonstrate the research findings in their full scope, this framework serves as an additional conceptual layer to improve the readability of the findings based on the author's interpretations. As can be seen from the graph presented above, three potential future scenarios come forth from this interpretation with the bottom left quadrant representing the state of Finnish primary care on the moment of conducting interviews in 2018.

Finnish primary care in 2018

The AI development in the Finnish primary care was in its early stages when this research started in 2018. Integration of AI solutions was primarily seen in the pilot projects happening across the industry when the technology has been moving from its conceptualization to the development phase. These pilot projects were initiated by both public and private companies who opted for funding pools provided by Business Finland, an investment organization founded by the Finnish Parliament on the 1st of January, 2018 (About Us). Citizens and healthcare industry professionals were not yet impacted in a profound way by the development of new AI tech. Medical operations running outside of the trial tech projects were executed mostly in a conventional manner. During the years 2017 and 2018, a lot of groundwork has been established for future AI development in the country through support and formation of new organisations, events, steering groups most prominent of which was Artificial Intelligence programme by Ministry of Economic Affairs and Employment of Finland that started on the 18th of May 2017 (Artificial Intelligence programme 2017).

Pro-government scenario

This scenario is formulated on the premise that the government will have a profound role in controlling AI development in the country and that the technological change will be primarily under the influence of organisational bodies. Digitalisation in the healthcare industry is administered and supported through governmental institutions and public companies. AI services are developed mostly through government contracts and from public funds. Social Welfare and Health Care reform is poised to facilitate the process of technology diffusion within the country's districts and make it more accessible to larger groups of people. Citizen's health data is stored in the national data banks under government protection. Public medical care services gain much more traction and development and become a new standard in industry operations, such as Kanta and VirtualiSairala (Virtual Hospital Initiative). Scientific and research development initiatives in healthcare are issued together with AI projects to find the most appropriate cases where the technology can bring the most

benefit. In such an environment, the majority of AI services in primary care that become available to the citizens will be provided on a tax-basis similar to the provision of other healthcare operations. Investments are made into the training of doctors and other medical personnel who will be involved in applying the new tech. This scenario represents the low-risk approach anticipated by the interviewees when concerns over security and privacy of citizens' health data are safeguarded by the government and when inequality of access to the healthcare services can be adjusted through the provision of new tech. However, the basis when technology is developed specifically from the state orders may hinder the innovativeness of the end solutions created for the market and citizens may not experience an extensive impact from the integration of AI technologies in their healthcare management experience.

Digitalization scenario

The focus in this scenario is centred around the increasing development of digital services and the widespread adoption of AI technologies among Finnish citizens where the customer choice comes before the priorities of the state. It is essentially a market-driven scenario when the end-consumers dictate the development of AI-based on their interests and needs. In the prospective future, interviewees saw the potential for full digitalisation of the primary care in the country which forms the core of this scenario. Citizens will consult with AI-supported systems through applications on their smartphone devices; these interactions will satisfy the majority of their personal healthcare needs. Hospitals transition to some extent to the virtual environment where doctors consult patients and assign any prescriptions through different means of telecommunication. Therefore, investments are made into telemedicine/telehealth infrastructure and respective network support across the country where AI can also be used to facilitate the provision of these new online services. Multiple health records are established in the country and citizens store their health data across different data banks, depending on their preferences. Digitalization scenario is open for any potential threats and challenges that interviewee's expressed related to the uncontrollable technological development. Concerns over data security, personal confidentiality of health information, risks of hacking and cyber-terrorism are all imaginable in this scenario. Moreover, this

scenario is the one that admittedly suggests that most of the new technological development would come from abroad and that the local companies will not be able to efficiently provide their services to the Finnish hospitals as much as international corporations. Citizens are expected to pay fees to foreign companies in order to use the new services. Despite this major apprehension in the statements of the research participants, the scenario could still lead to significant technological progress with major benefits to the end consumer and even potentially lead to the creation of new operational healthcare environment altogether.

Neutral / Balanced scenario

The scenario in the upper right quadrant depicts a version of the future where both technological progress and governmental involvement impact the adoption of AI technologies in primary care on a high level. In this version of the future, there is no single dominating force that drives the development of the AI-enabled services, rather a combination of several that complement and likely reduce each other's risks and threats. Both public and private companies are expected to take part in the creation of AI solutions for the Finnish market with a moderate level of influence from international corporations. The AI technologies are developed according to the personal needs of the citizens as well as organisational demands of the medical care units across the country. Multiple pricing models for the use of AI services can be seen; tax-based, freemium, subscription, fee-based and else. Clinicians take an active part in education and research related to the use of new technologies in medical operations and have their stake on influencing the functionalities of AI available to their patients. Risks associated with data sensitivity and technological errors exist, but there are governmental and non-governmental organisations in place to enact the necessary security measures and preventive mechanisms. The AI gains a wide adoption in the operations of primary care which paves a way for its potential future realization and development in secondary and tertiary care.

5.2 Theoretical implications of the results

The main conclusions that are derived from the analysis of the research findings coincide with recent works in the futures research which suggest that technology is generally developing faster than humans can adapt to its development (Friedman 2017). Human's adaptability to technological change is increasing, however, it is not able to match the speed of scientifical and technological advancements. The created gap can be reduced through the development of skills that foster faster processing of information, quicker experimentation and iteration and overall improvement of learning techniques (Friedman 2017). Every technology requires some time for people to adapt to its usage, albeit digital technology is thought to require the most resources from an individual to get accustomed to because the interactions between user and technology are not happening in the traditional, but the virtual environment. The representation of this theory can be expressed in the graph below.

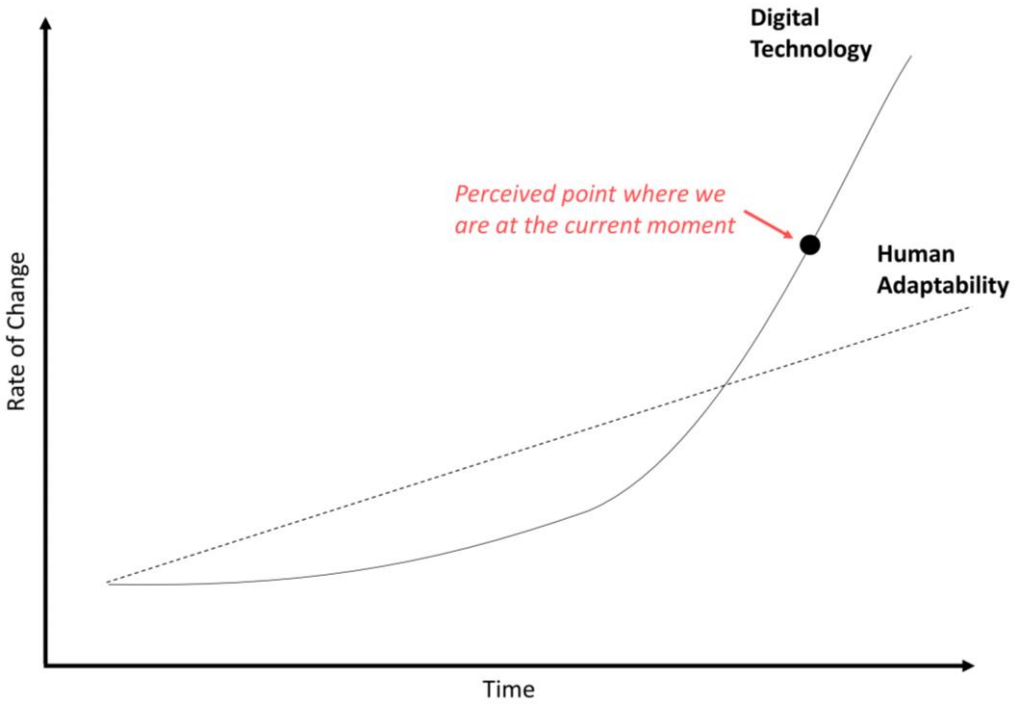


Figure 20. Visualisation of the concept of accelerating change (Adapted from Friedman 2017)

In light of the conducted research, the development of AI technologies is happening faster in the industry than they are being implemented in the form of viable business

solutions to the consumers. The AI has already found its use in scientific medical research, however, no conceivable approach to integrating the AI technologies for the use of patients has yet been developed. The interviewees named a considerable number of stopping factors that could prevent the diffusion of technologies happening faster. Both technological- and human-related factors were brought up, however, the proportion of the latter was much bigger. Such issues as the privacy of citizens' health data, lack of skills among clinicians and patients to interact with AI-supported systems, human errors in the administration of AI-enabled diagnostics, the ambiguity of responsible party for the provision of medical care through AI technologies will all take a substantial amount of time to be resolved to allow citizens to experience the full practical potential of AI in primary care.

Further research in the field of futures studies argued that the human capacity to adapt is not limited or pre-determined by our biological limits, e.g. cognitive limitations of our brain, thus it can be significantly altered and improved (Roser and Ritchie 2013). Nonetheless, the studies do not deny the fact that the gap between new technologies being developed and humans educating themselves to interact with them is progressively widening, this gap can be to a certain extent shortened through dynamic training and teaching techniques. Furthermore, the adaptability of individuals is not the same as of companies and institutions that these individuals comprise (Bersin, Pelster & Schwartz 2017). Organizations that consist of multiple individuals have to take much more effort to evaluate the impact of technologies on every single organization member, thus their adaptability to technological change is lower. The technological gap can also be referred to as technological debt meaning the later action is taken to counter the cultural lag, the higher will be the interest payable to counter-measure the accumulated gap (Bocci 2019). The implications of the research can be represented in the following graph.

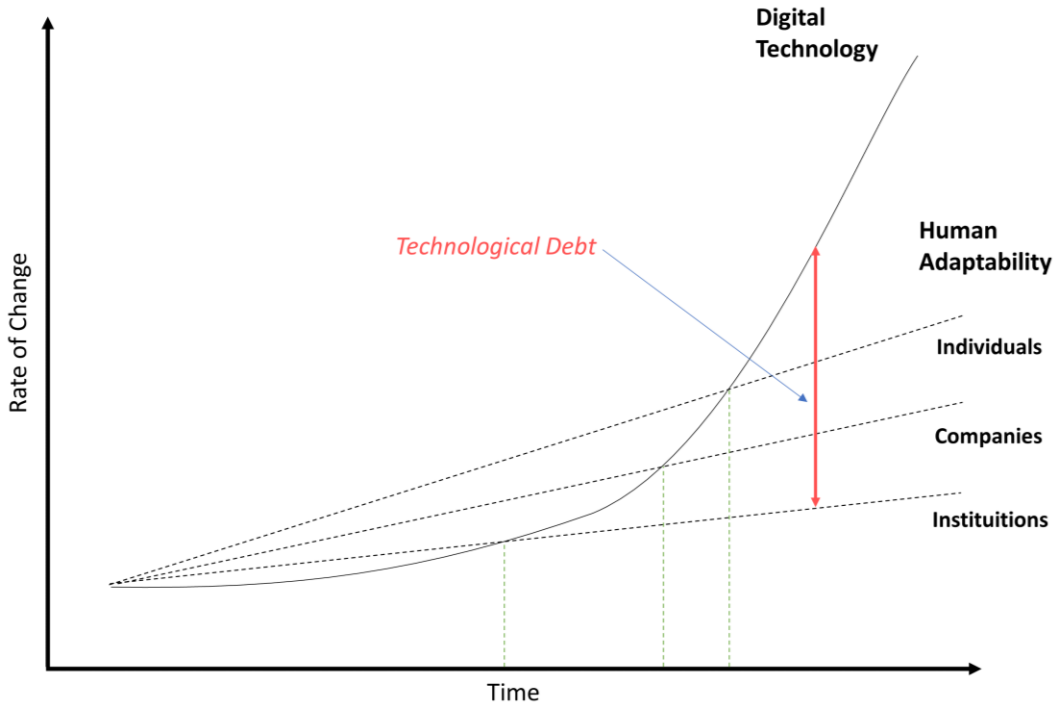


Figure 21. Graph of individual, organisational, and institutional adaptability to the technological change (Adapted from Bocci 2019)

The different adaptability between individuals, companies and organizations also corresponds with the research findings. The consequences represented in organizational and personal perspectives of the radars directly imply the groundwork that needs to be done before the AI technologies can be distributed across the Finnish market of primary care. While individuals may be the first ones to use AI-powered applications for their healthcare management, integration of AI software in hospitals may come to the realization a lot later due to regulations and legalities that need to be in place before this technology can be used in the patient treatment. Another theory that explores the capacity of organizations to adapt to technological change is Martec's Law which states that "technology changes exponentially; organizations change logarithmically" (Brinker 2016). This law is formed on the basis of other laws characterizing the technological development such as Moore's Law of the rapid growth of computational power in semiconductor circuits, Ray Kurzweil's law of accelerating returns, Metcalfe's law of the increasing value of interconnections within the expanding network and others (Roser and Ritchie 2013). Martec's Law is commonly visualised as two curve graph; one for technological change and one for organizational change.

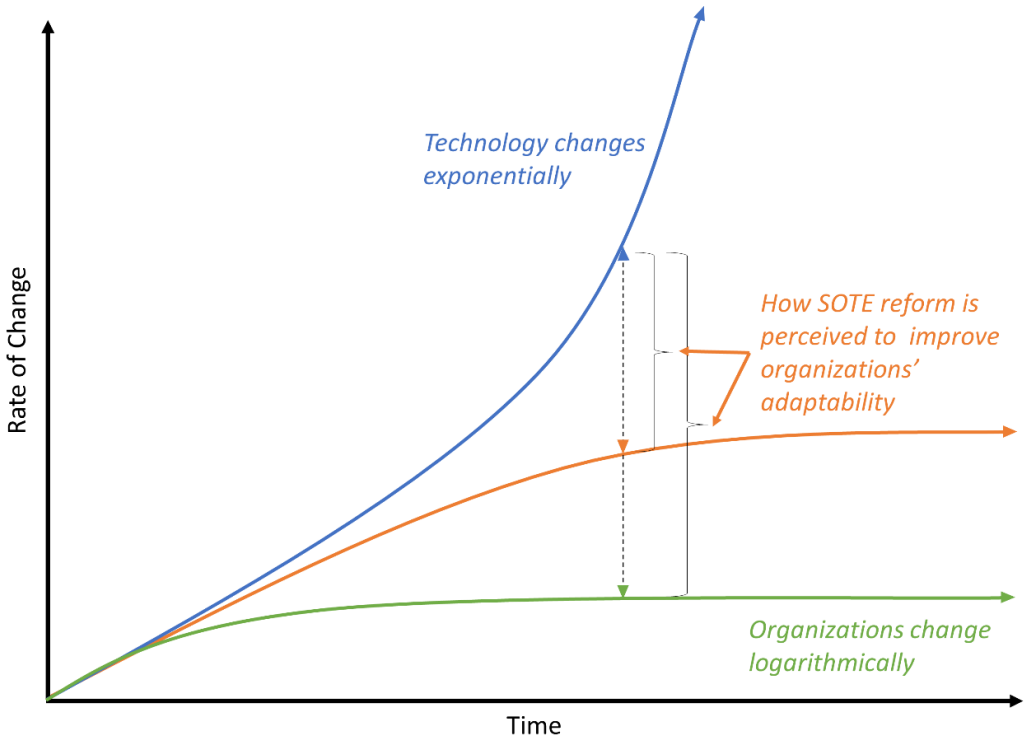


Figure 22. Representation of Martec's Law together with proposed research findings (Adapted from Brinker 2016)

The orange curve which was added on the traditional representation of the Martec's Law represents a possible improvement in the adaptability of organizations to the anticipated AI development in primary care which can be partially achieved through Social and Healthcare system reform. The research participants anticipated that through the reform healthcare organizations can gain the required flexibility to meet the technological changes and thus, improve the provision of medical care. Administration of hospitals and other medical units are expected to choose which technologies to adopt from available to them and AI is seen as the one that can bring most organizational value through e.g. automation of repetitive managerial tasks.

When trying to estimate the future timeframe when AI technologies will be adopted in the Finnish primary care, an s-curve that represents the life cycle of technologies can be implemented to visualize the interviewees' estimations. The s-curve graph has widely been used by marketers and future researchers to demonstrate how technologies develop from ideas to test solutions to new market offers and then becoming a new norm (Lum 2016). The same perception applies to how research

participants see AI technologies unfold in primary care in the future. The presented s-curve graph is contextualized with opinions from the research sample related to the future estimations on stages through which AI will be diffused.

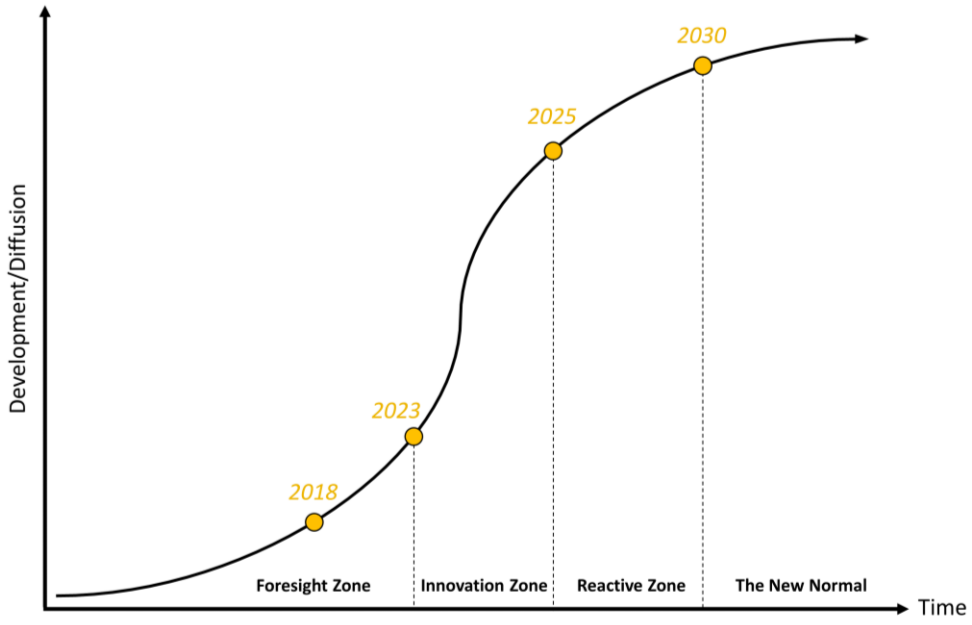


Figure 23. S-curve graph of technology diffusion contextualized with interviewees' opinions (Adapted from Lum 2016)

The research participants anticipate that in 5 years from the moment of conducting interviews (2018 to 2023) most of the organisational work related to the future integration of AI tech in primary care will be complete. This includes issuing of the respective laws aimed at ensuring confidentiality and protection of citizens' sensitive health information, the foundation of AI accelerators across the country to boost research initiatives, creation of funding pools tied to business and science projects on AI development. These factors will precede further advancements in the adoption of AI solutions from 2023 to 2025. During this relatively short timespan, interviewees expect to see a rise in AI application throughout the industry from both public and private companies in their future market offers. Provided that before 2023 majority of the considerations for the adoption of the new technology will be resolved, it will allow all predisposed companies to experiment on integrating the new solutions. After the peak of experimentation, the created business solutions for primary care using AI will then be tested in the market. This period of evaluation of applicability,

feasibility and viability of new business offers is expected to take around 5 years between 2025 and 2030. The AI technology could achieve its adoption in the market and become “the new normal” after 2030 – this year is as far as any of the predictions of the interviewees’ have gone. There is no currently any research or analysis of the Finnish healthcare market to support this hypothesis, however, there are several recent international publications where AI adoption in the healthcare of the future is anticipated in more or less the same fashion. For instance, similar findings can be traced in an article published as part of World Economic Forum Annual Meeting where the author suggests that by 2030 “health systems around the globe will be able to deliver truly proactive, preventive healthcare enabled by predictive analytics and machine learning integrated into the AI solutions” (Kriwet 2020). Likewise, coinciding implications for AI adoption by 2030 were published in the journal of HealthManagement where several clinicians shared their expectations of the widespread adoption of AI-powered telehealth and medical imagining services (Healthcare 2030: Transformation in the Next Decade 2020, 62-63).

The discussed theoretical implications of the study demonstrate that the Finnish healthcare system could benefit from futures research. Through different future methodology tools, it is possible to make projections on certain trends and how they can unravel in the future. This study was revolved around the trend of AI integration in primary care, after all, it is not the only trend affecting the healthcare industry. The same research framework can be used to assess the impact and outline perspective directions of development of other trends as well.

5.3 Practical implications of the results

The development of AI technologies has been widely discussed as an “entry point to the 4th industrial revolution” (Skilton & Hovsepian 2018). The disruptive technological potential of Artificial Intelligence has been studied by the researchers and marketers who try to estimate the potential benefits and challenges that this technology can bring to the industries worldwide. When it comes to the healthcare sector, the potential for change is unprecedented. Conventional means of operation can be

significantly altered with the introduction of AI and completely new business models can emerge on the same premise. Nevertheless, like with any technology, there are associated lags of development that can prevent or postpone its adoption in the market. The futures research is essentially useful in this regards to help identify these stopping factors and assist involved stakeholders in devising scenarios of development for the desired future.

The unique feature of this research is its examination of prospective directions of development of AI technologies in the Finnish primary care on multiple levels. The research does not only focus on the projected developments of the technology in question but stipulates from the fact that personal and organizational implications will be of significance in the adoption of this technology. Therefore, estimations and projections can be made for possible futures to be achieved.

Over the years healthcare delivery has become complex and challenging. Much of the complexity of delivering healthcare is due to the voluminous data generated in the healthcare process, which must be interpreted in an intelligent fashion. AI systems can address that need with their problem-solving approach. It is alluring to see their intelligent design, which combines thinking and logic and the ability to act autonomously without requiring constant human attention. Thus the medical domain has given AI researchers a fertile ground at testing their techniques and in many instances, AI applications have successfully solved problems with results comparable to those of human clinicians. As healthcare delivery becomes more costly, consumers are constantly looking for solutions that can replace the expensive elements in patient care, and in such cases, AI solutions are being pursued. However, the created business offerings can not completely replace the human element in patient care, and it is necessary to investigate a model which incorporates both technological innovations and human care. (Bhatt, Dey & Ashour 2017, 243-247.)

AI and automation have the potential to transform the delivery of care – addressing both the need for better and more cost-effective care and helping to fill some of the expected staff shortfalls. This is particularly true as populations age and their health needs are becoming more complex. AI and automation are put in a unique position

to help understand these needs and the complex interdependence between different factors which affect the health of the population. Moreover, the extraordinary shift from symptom-based medical practice to molecular and cellular medicine is generating ever-increasing data volumes. In such a setting, AI can add value and help speed up new biomedical developments, the process of diagnosis and treatment access. (Natarahan, Frenzel & Smaltz 2017, 89-93.) AI is still some way from delivering on all its potential, but the consensus among healthcare experts, AI developers and investors involved in this study is that AI's potential remains significant in healthcare.

Besides the stakeholders present in the field of the Finnish healthcare, the findings of this research can also be useful to the potential investors and stakeholders from other industries looking to find additional guidance and context to their future business decisions associated with technological development in the healthcare.

5.4 Limitations of the research

The research conducted in this thesis has several limitations, which could have had an impact on the results. The main limitation highlighted by the researcher is the iterative nature of the futures studies which requires a constant update of the results. Since this study stemmed from the fact that no single future can be estimated beforehand and that there are multiple possible futures influenced by the actions of social actors, it is possible that the estimations and projections made in this study can be impacted by updated projections of the stakeholders on the time of publishing. The process of devising futures is based on continuous refinement of the results, thus additional rounds of analysis are necessary to be up to date with a prospective course of development.

The second limitation is connected to the analysis techniques employed in this research. Both scenarios and multiple perspectives have their limitations when it comes to aiding the researcher to devise probable future(s). The limitations of these methods such as the analysis scope or factors and perspectives taken into

consideration is possible to overcome through the application of other futures research methods.

The third limitation of this research may be attributed to the research sample. The research attempted to investigate the research problem from multiple angles, however, not every single point of view has been considered. The author recognizes that the patient perspective has been evaluated in the study on the premise of every single interviewee taking on a potential role of future patient and thus, sharing correlated expectations and anticipations. The study could have benefited from the inclusion of opinions of interview participants that represent the patient or the consumer side of the spectre. Again, even though all the interview participants can potentially be regarded as customers of the Finnish primary care, their opinions are still inherently biased from the side of the appliers and developers of the discussed technology. This research looked to the experts from the field to gather their opinions about potential futures; hence, this study could be complemented by the similar data collection and analysis done from the perspective of the target customer base.

5.5 Recommendations for future research

There is a variety of potential vectors for further research that can be conducted on the topic of AI technologies. The same disruptive potential of Artificial Intelligence can be investigated in other industries, nevertheless, the author believes that there are yet many insights to uncover within the realm of the healthcare industry. The implications of the research transcend the area of primary care with potential consequences of AI adoption identified for its utilization in secondary and tertiary care; therefore, additional research can be done on those segments. The same combination of futures research methods can be implemented to assess the trends of AI adoption in secondary and tertiary care and then the results can be compared to provide an overall future insight on the AI application in the Finnish healthcare.

Recommendations for future studies also include a suggestion to conduct the same research in the international context. Healthcare systems of the participating countries in the Nordic-Baltic regional agreement on AI can be analyzed on the potential integration of the AI technologies. The results of this study could also inform future research. In the same example of international research, the findings can be tested whether the trends identified for the Finnish primary care would be relevant to the Swedish or Norwegian systems of primary care. Such research can potentially go in line with the Nordic co-operation agenda in regards to the project on the AI collaboration between Finland and other member countries.

The study identified three major trends that could potentially influence the adoption of AI in primary care with those being pre-, during and post-diagnostic stages. However, the operations of primary care do not sum up to the process of diagnostics and other areas can be investigated further on any potential premise for AI adoption. Such areas of primary care as pharmacy, dentist, optician, mental health care services can be evaluated on the potential for AI adoption within their operations.

Future research can also take into account the consumer perspective more rigorously. The author believes that quantitative futures research methods, such as system dynamics, time series forecast and trend impact analysis are all suitable to provide additional numerical projections to contextualize this and further studies.

References

About Us. Page on Business Finland's official website. Accessed on 10 June 2018. Retrieved from https://www.businessfinland.fi/en/for-finnish-customers/about-us/in-brief/

Aguis, C. 2019. *Evolution of AI: Past, Present, Future*. Article on the DataDrivenInvestor website. Accessed on 15 February 2019. Retrieved from https://medium.com/datadriveninvestor/evolution-of-ai-past-present-future-6f995d5f964a

AI Forum. 2018. An article published on the Tekoälyaika [Time of Artificial Intelligence] website. Accessed on 28 November 2018. Retrieved from: https://www.tekoalyaika.fi/en/ai-forum-2018/

AI in the Nordic-Baltic region. 2018. Declaration published on the Nordic Co-operation official website. Nordic Council of Ministers for Digitalization. Accessed on 26 June 2018. Retrieved from https://www.norden.org/en/declaration/ai-nordic-baltic-region

AI's transcendence. 2018. An article on the UBS official website. Accessed on 12 March 2018. Retrieved from https://www.ubs.com/microsites/artificial-intelligence/en/transcendence.html

Aligica, P. D. 2011. A critical realist image of the future Wendell Bell's contribution to the foundations of futures studies. *Futures, 43*, 610-617.

Al-Saadi, H. 2014. *Demystifying Ontology and Epistemology in Research Methods*.

Allison, G., Zelikow, P. 1971. *Essence of Decision: Explaining the Cuban Missile Crisis*. 1st ed. Pearson.

Alvesson, M. 2003. Methodology for close up studies – struggling with closeness and closure. *Higher Education, 46(2)*, 167-193.

Arksey, H. & Knight, P. 1999. *Interviewing for Social Scientists: An Introductory Resource with Examples*. London, Sage.

Artificial Intelligence and Machine Learning in Financial Services. 2017. Pdf document on the Financial Stability Board (FSB) official website. Accessed on 25 January 2018. Retrieved from https://www.fsb.org/wp-content/uploads/P011117.pdf

Artificial Intelligence: Healthcare's new nervous system. 2018. An article on the Accenture official website. Accessed on 3 February 2018. Retrieved from https://www.accenture.com/fi-en/insight-artificial-intelligence-healthcare

Artificial intelligence programme. 2017. Page on the Ministry of Economic Affairs and Employment of Finland official website. Accessed on 26 February 2018. Retrieved from https://tem.fi/en/artificial-intelligence-programme

Artificial Intelligence. The next digital frontier? Discussion paper published by McKinsey Global Institute. Accessed on 27 January 2018. Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/advanced%20electronics/our%20insights/how%20artificial%20intelligence%20can%20deliver%20real%20value%20to%20companies/mgi-artificial-intelligence-discussion-paper.ashx

Artificial Intelligence. Article published on the Investopedia website. Accessed on 10 February 2018. Retrieved from https://www.investopedia.com/terms/a/artificialintelligence-ai.asp

Bell, W. 2003. *Foundations of Futures Studies. History, Purposes and Knowledge: Human Science for a New Era*. Volume 1. New Brunswick & London: Transaction Publishers.

Bersin, J., Pelster, B., & Schwartz. 2017. Rewriting the Rules of Digital Age. *Deloitte Global Human Capital Trends*.

Bhat, C., Dey, N. & Ashour, A. 2017. *Internet of Things and Big Data Technologies for Next Generation Healthcare*. 1st ed. Springer International Publishing.

Boe-Lillegraven, S. & Monterde S. 2015. Exploring the cognitive value of technology foresight: The case of the Cisco Technology Radar. *Technological Forecasting and Social Change, 101*, 62-82.

Bocci, F. 2019. *Digital Transformation and Technological Debt*. Article on BeingBetterMatters website. Accessed on 15 April 2020. Retrieved from https://www.beingbettermatters.net/digital-transformation-and-technological-debt/

Brinker, S. 2016. *Martec's Law: the greatest management challenge of the 21st century*. Article on Chiefmartec website. Accessed on 15 April 2020. Retrieved from https://chiefmartec.com/2016/11/martecs-law-great-management-challenge-21st-century/

Business Finland. Sub-portal from the Team Finland official website. Accessed on 10 June 2018. Retrieved from https://www.businessfinland.fi/en/do-business-with-finland/home/

Coates, F. 1985a. *Scenarios Part One: The Future Will Be Different from the Present. What Do I Have to Do to Persuade You? Nonextrapolative Methods in Business For casting*. Westport, Connecticut: Quorum Books.

Coates, F. 1985b. *Scenarios Part Two: Alternative Futures. Nonextrapolative Methods in Business Forecasting*. Westport, Connecticut: Quorum Books.

Coleman, P. 2019. In-Depth Interviewing as a Research Method in Healthcare Practice and Education: Value, Limitations and Considerations. *International Journal of Caring Sciences, 12(3)*, 1879-1885.

Conrad, C., Neumann, A., Haworth, J. G., & Scott, P. 1993. *Qualitative research in higher education: Experiencing alternative perspective and approaches*. Needham Heights, MA: Ginn Press.

Considering the potential business impacts of the COVID-19 outbreak. 2020. Presentation published by the PwC consulting company. Accessed on 21 March 2020. Retrieved from https://www.pwc.com/m1/en/publications/covid-19/considering-the-potential-business-impacts-covid-19-outbreak.pdf

Creswell, J. W. 2007. *Research design: Qualitative and quantitative approaches*. 2nd ed. Thousand Oaks, CA: Sage.

Creswell, J.W. 2007. *Qualitative inquiry and research design: Choosing among five approaches*. 2nd ed. Thousand Oaks: Sage Publications.

Cuhls, K., Kolz, H. & Hadnagy, C. M. 2012. A regional foresight process to cope with demographic change: future radar 2030. Zukunftsradar 2030 [Future radar 2030]. I*nternational Journal of Foresight and Innovation Policy*, *8(4)*, 311-334.

De Jouvenel, B. 1967. *The Art of Conjecture*. London: Weidenfeld and Nicholson.

Echalliance Ecosystems. 2018. Article on The European Connected Health Alliance official website. Accessed on 18 March 2018. Retrieved from https://echalliance.com/ecosystems/

Edelläkävijänä tekoälyaikaan [*Leading the way into the Age of Artificial Intelligence*]. 2019. Pdf document published on the Finnish Ministry of Economic Affairs and Employment official website. Accessed on 19 September 2018. Retrieved from http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161688/41_19_Leading%20the%20way%20into%20the%20age%20of%20artificial%20intelligence.pdf

Eriksson, P., & Kovalainen, A. 2008. *Introducing Qualitative Methods: Qualitative methods in business research*. London: SAGE Publications Ltd.

Filintseva, Z. 2019. Public-Private Collaboration and Creating Shared Value in Finnish healthcare sector. Bachelor's thesis. JAMK University of Applied Sciences, School of Business, Degree Programme in International Business. Accessed on 10 January 2020. Retrieved from http://urn.fi/URN:NBN:fi:amk-2019121025651

Finland. Country Health Profile. 2017. Report of OECD and the World Health Organization on the state of health in the EU. Accessed on 17 February 2018. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0011/355979/Health-Profile-Finland-Eng.pdf?ua=1

Finnish Institute for Health and Welfare. Frontpage on the Finnish Institute for Health and Welfare official website. Accessed on 30 March 2018. Retrieved from https://thl.fi/en/web/thlfi-en

Friedman, T. 2017. *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations*. Farrar, Straus and Giroux, New York.

Gaßner, R., & Kosow, H. 2008. *Methods of Future and Scenario Analysis: Overview, assessment, and selection criteria*. Studies/Deutsches Institut für Entwicklungspolitik [German Development Institute], Germany, Bonn.

Ghauri, P., & Grønhaug, K. 2002. *Research methods in business studies: a practical guide*. 2nd ed. Harlow: Pearson Education Limited.

Glaser, B. G., & Strauss, A. L. 1967. *The discovery of grounded theory: Strategies for qualitative research*. Hawthorne, NY: Aldine.

Glaser, B.G. 2008. *Doing Quantitative Grounded Theory*. Sociology Press, Mill Valley.

Glenn, J. C. 2010. *Future Research Methodology, The Millennium Project*. 2nd ed. Volumes 1 -27. AmericanCouncil for United Nations University.

Gottfredson, L. 1997. Why g matters: The complexity of everyday life*. Intelligence, 24(1)*, 79-132.

Griffin, P.M., Nembhard, H.B., DeFlitch, C.J., Bastian, N.D., Kang, H. and Muñoz, D.A. 2016. *Healthcare systems engineering*. John Wiley & Sons.

Guarino, N., Oberle, D. & Staab, S. 2009. What Is an Ontology? *Handbook on Ontologies, 1–17*.

Hastings J., Selbie J. A. & Gray L. H. 1908. *Encyclopedia of religion and ethics*. Edinburgh: T. & T. Clark.

Health care in Finland. 2013. Pdf document published by the Finnish Ministry of Social Affairs and Health. Accessed on 15 February 2018. Retrieved from http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/69930/URN_ISBN_978-952-00-3395-8.pdf

Healthcare 2030: Transformation in the Next Decade. 2020. *Journal of HealthManagement, 20(1)*, 62-63.

Heijden, K. 2000. Scenarios and forecasting: Two perspectives. *Technological Forecasting and Social Change, 65(1)*, 31-36.

Hintze, A. 2016. *Understanding the Four Types of Artificial Intelligence*. Article on the GovernmentTechnology website. Accessed on 15 March 2018. Retrieved from https://www.govtech.com/computing/Understanding-the-Four-Types-of-Artificial-Intelligence.html

Holloway, I. 1997. *Basic concepts for qualitative research*. Bodmin: Hartnolls Ltd.

Inayatullah, S. 2013. Futures Studies: theories and methods. *There's a Future: Visions for a better world*, 36-66.

Jenner, A. 2017. *The Evolution of Artificial Intelligence*. Article on the TecAdmin website. Accessed on 14 April 2018. Retrieved from: https://tecadmin.net/evolution-ofartificial-intelligence/

Kananen, J. 2011. *How to enter international markets: a guide for SMEs*. Jyväskylä: JAMK University of Applied Sciences.

Kassirer, J. 1989. Our stubborn quest for diagnostic certainty. A cause of excessive testing. *New England Journal of Medicine. 320(22)*, 1489–1491.

Kassirer, J., Wong, J. & Kopelman R. 2010. *Learning clinical reasoning*. Baltimore: Williams & Wilkins.

Kela. Frontpage on the Kansaneläkelaitos, The Social Insurance Institution of Finland, main website. Accessed on 28 April 2018. Retrieved from https://www.kela.fi/

Koller, C. & Khullar, D. 2017. *Primary Care Spending Rate — A Lever for Encouraging Investment in Primary Care*. New England Journal of Medicine, 377(18), 1709-1711.

Kriwet, C. 2020. *Here are 3 ways AI will change healthcare by 2030*. Article on the WorldEconomicForum official website. Accessed on 24 April 2020. Retrieved from https://www.weforum.org/agenda/2020/01/future-of-artificial-intelligence-healthcare-delivery/

Kuosa, T. 2011. Evolution of futures studies. *Futures, 43*, 327-336.

Kuzel, A. 1999. *Sampling in Qualitative Inquiry. Doing Qualitative Research*. 2nd ed. Sage Publications, Thousand Oaks.

Kvale, S. 2006. Dominance Through Interviews and Dialogues. *Qualitative Inquiry, 12(3)*, 480-500.

Leung L. 2015. Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care, 4(3)*, 324-327.

Lindlof, T., & Taylor, B. 2011. *Qualitative communication research methods*. 3rd ed. Los Angeles: SAGE publications Ltd.

Linstone, H. 1994. *The Challenge of the 21st Century: Managing Technology and Ourselves in a Shrinking World*. New York, SUNY Press.

List, D. 2005. Scenario Network Mapping: The Development of a Methodology for Social Inquiry. *Doctoral dissertation: Division of Business and Enterprise University of South Australia*.

Locke, K. 1996. Rewriting the discovery of grounded theory after 25 years? *Journal of Management Inquiry*, *5*, 239-246.
Lum, R. 2016. *4 Steps to the Future: A Quick and Clean Guide to Creating Foresight*. 1st ed. Vision Foresight Strategy LLC

Lundén, R. 2019. A Foresight and Strategic Development Proposals for Sport Business in Finland by 2025. Bachelor's thesis. JAMK University of Applied Sciences, Sports Business, Degree Programme in International Business. Accessed 21 October 2019. Retrieved from http://urn.fi/URN:NBN:fi:amk-2019060615217

Luton, L. S. 2010. *Qualitative Research Approaches for Public Administration*. Armonk: M.E. Sharpe.

Mannermaa, M. 1999. *Tulevaisuuden hallinta* [Managing the future]. Porvoo: WSOY.
Martino, J. 1972. *Technological Forecasting for Decision Making*. New York: Elsevier.

McGivern, Y. 2006. *The practice of market and social research: an introduction*. 2nd ed. Harlow: Pearson Education Limited.

Miles, M.B., Huberman, A.M., Saldana, J. .2014. *Qualitative Data Analysis: A Methods Sourcebook*. London, Sage.

Ministry of Social Affairs and Health. Frontpage on the Ministry of Social Affairs and Health official website. Accessed on 18 January 2018. Retrieved from https://stm.fi/en/frontpage

Natarajan, P., Frenzel, J., & Smaltz, D. 2017. *Demystifying Big Data and Machine Learning for Healthcare*. 1st ed. CRC Press.

Neittaanmäki, P. 2017. *Value from health data with cognitive computing*. Report published on the official website of Jyväskylän yliopisto [University of Jyväskylä]. Accessed on 15 January 2018. Retrieved from https://www.jyu.fi/it/julkaisut/Loppuraportti301017.pdf

Noble, H., & Smith, J. 2015. Issues of validity and reliability in qualitative research. *Evidence-Based Nursing, 18(2)*.

Patomaki, H. 2006. Realist Ontology for Futures Studies. *Journal of Critical Realism, 5(1)*, 1-31.

Patton, M. 1990. *Qualitative evaluation and research methods*. 2nd ed. Newbury Park, CA: Sage.

Parasuraman, R., Sheridan, T. & Wickens, D. 2000. A model for types and levels of human interaction with automation. *IEEE Transactions on Systems, Man and Cybernetics—Part A: Systems and Humans, 30(3)*, 286–297.

Poli, R. 2011. Steps Toward an Explicit Ontology of the Future. *Journal of Futures Studies, 16(1)*, 67-78.

Popper, R. 2008. Foresight Methodology. *The Handbook of Technology Foresight*, 44-88. Edward Elgar, Cheltenham.

Puglisi, M. 2001. The study of the futures: an overview of futures studies methodologies. *Bari: CIHEAM. Options Mediterraneennes, Serie A. Seminaires Mediterraneens* [Mediterranean Options, Serie A. Mediterranean Seminars], 44.

Ragab, M. and Arisha, A. 2018. Research Methodology in Business: A Starter's Guide. *Management and Organizational Studies, 5*.

Rajasekar, S., Philominathan, P. and Chinnathambi, V. 2006. *Research methodology*, *Ar XIV Physics*.

Ray, S. 2018. *Four types of AI*. Article published on the Codeburst.io website. Accessed on 15 September 2018. Retrieved from https://codeburst.io/four-types-of-ai-6aab2ce57c19

Rescher N. 1998. *Predicting the Future. An introduction to the theory of forecasting*. State University of New York Press, Albany.

Reynoso, R. 2019. *4 main types of Artificial Intelligence*. Article published on the LearningHub website. Accessed on 25 April 2019. Retrieved from https://learn.g2.com/types-of-artificial-intelligence

Roser, M. & Ritchie, H. 2013. Technological Progress. Article on OurWorldInData website. Accessed on 17 March 2020. Retrieved from https://ourworldindata.org/technological-progress

Sarter N. 2014. User-centered design of health IT: Challenges and lessons learned. Washington, DC.

Saleh, M., Agami, N., Omran, A., & El-Shishiny, H. 2008. A survey on futures studies methods. *Cairo: Faculty of Computers and Information-Cairo University-INFOS*, 38-46.

Saukkonen, J. & Lundén R. 2018. *Incorporating Futures Foresight into Strategic Renewal in Sports Business*. Jyväskylä: JAMK University of Applied Sciences.

Saunders, M., Lewis, P. and Thornhill, A. 2016. *Research methods for business students*. 7th ed. Harlow: Pearson Education.

Schwab, K. 2016. *The Fourth Industrial Revolution: what it means, how to respond*. Article on the WorldEconomicForum website. Accessed on 15 March 2018. Retrieved

from www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-itmeans-and-how-to-respond/

Schwandt, T. & Halper, S. 1998. *Linking auditing and metaevalutaion: Enhancing quality in applied research*. Newbury Park CA: Sage.

Schwartz, P. 1991. *The Art of the Long View: Planning for the Future in an Uncertain World*. New York: Doubleday.

Schwartz, P. 1992. Composing a Plot for Your Scenario. *The Planning Forum, 20(3)*, 232-234.

Shani, O. 2018. *From Science Fiction to Reality: The Evolution of Artificial Intelligence*. Article on the Wired website. Accessed on 21 April 2018. Retrieved from: https://www.wired.com/insights/2015/01/the-evolution-of-artificial-intelligence/

Shelby, L. 2017. Healthcare drives yearly job growth. An article on the ModernHealthcare website. Accessed on 18 January 2018. Retrieved from: http://www.modernhealthcare.com/article/20170106/NEWS/170109951

Sidda, S., Kiranmayi, R. & Nagaraju, P. 2017. A Review on Artificial Intelligence Techniques in Electrical Drives Neural Networks, Fuzzy logic, and Genetic Algorithm. *SmartTechCon, 10(1109)*, 55-60.

Silverman, D. 2016. *Qualitative Research*. 4th ed. SAGE Publications Ltd.

Skilton, M. & Hovsepian F. 2018. *The 4th Industrial Revolution*. 1st ed. Palgrave Macmillan.

Social Welfare and Health Care reform. An online page from the Valtioneuvosto, the Finnish Government, official website. Accessed on 26 April 2018. Retrieved from https://soteuudistus.fi/etusivu

Spalding, H. 2018. *Anonymous and pseudonymous data: Are they actually important?* Article on Data & Marketing Association website. Accessed on 20 August 2018. Retrieved from https://dma.org.uk/article/anonymous-and-pseudonymous-data-are-they-actually-important

Statistics Finland, 2018. *Official Statistics of Finland (OSF): Labour force survey*. Accessed on 15 June 2018. Retrieved from http://www.stat.fi/til/tyti/index_en.html

Strauss, A., & Corbin, J. 2008. *Basics of qualitative research: Grounded theory procedures and techniques*. 3rd ed. Newbury Park, CA: Sage.

Strauss, A., & Corbin, J. 2008. *Basics of qualitative research: Grounded theory procedures and techniques*. 3rd ed. Newbury Park, CA: Sage.

Suomen tekoälyaika [*Finland's age of Artificial Intelligence*]. 2017. Pdf document published on the Finnish Ministry of Economic Affairs and Employment official

website. Accessed on 19 January 2018. Retrieved from http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160980/TEMjul_21_2018_Work_in_the_age.pdf

Taherdoost, H. 2016. Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management, 5*, 18-27.

Takyar A. 2018. *What is Artificial Intelligence? Understand Artificial Intelligence in 5 minutes*. Article on LeewayHertz website. Retrieved from: https://www.leewayhertz.com/what-is-artificial-intelligence-understand-ai-in-5-minutes/

Taylor, S. J., & Bogdan, R. 1998. *Introduction to qualitative research methods: A guidebook and resource*. 3rd ed. New York: Wiley.

Tekoälyajan työ [*Work in the Age of Artificial Intelligence*]. 2018. Pdf document published on the Finnish Ministry of Economic Affairs and Employment official website. Accessed on 19 September 2018. Retrieved from http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160980/TEMjul_21_2018_Work_in_the_age.pdf

Teperi, J., Porter, M.E., Vuorenkoski, L. and Baron, J.F. 2009. The Finnish health care system: a value-based perspective. *Sitra reports, 82*.

The World's Most Efficient Healthcare System. 2018. Article on BusinessFinland website. Accessed on 28 January 2018. Retrieved from https://www.businessfinland.fi/en/do-business-with-finland/explore-finland/health-wellbeing/in-brief/

Turpin, M., Phahlamohlaka, J. and Marais, M. 2009. The Multiple Perspectives Approach as a Framework to Analyze Social Systems in a Developing Country Context. *10th International Conference on Social Implications of Computers in Developing Countries*, 353-365.

Virtual Hospital Initiative. Page on Health Village project website. Accessed on 27 May 2018. Retrieved from https://www.virtuaalisairaala2.fi/en/virtual-hospital-initiative

Walshe, K. and Smith, J. 2011. *Healthcare management*. McGraw-Hill Education (UK).

Yaninen, D. 2017. *Artificial Intelligence and the Accounting Profession in 2030*. Article online on the CertifiedPractisingAccountants official website. Accessed on 19 January 2018. Retrieved from https://cpapng.org.pg/data/documents/CPA-Presentation-Artificial-Intelligence-and-the-AccountingProfession-in-2030_1.pdf

Vinge, V. 1993. Technological Singularity. *Interdisciplinary Science and Engineering in the Era of Cyberspace, 21*, 11-22.

Appendices

Appendix 1. Table of Research Findings

Instruction on how to read the table

The cells of this table are divided across three trends, two levels of consequences and three perspectives.

The table is made in such a way that consequences within each trend do not overlap with consequences from other trends. The connections between the consequences are established within a concrete trend.

If a consequence of the 1st order has a matching consequence of the 2nd order, it will:

- either be placed in the adjacent cell or
- in the cell of a different perspective and the following code is used to trace the connection, example "cell with a code T.1.1 – 5 has connections with cells with codes O.1.2 – 5 and P.1.2 – 5".

"T" – the first letter stands for perspective – either T (technological), O (organizational) or P (personal).
"1" – the number in the middle stands for the number of the trend – either 1st, 2nd or 3rd.
"1" – the second number stands for the order of the consequence – first or second.
"5" – the last number identifies the connection. They are unique for each connection and there are overall 36 such identifiers in the table.

Each statement in the table of research findings is marked with codes of the respective interviewees. Refer to tables 1 and 2 for additional information.

Abbreviation	INC	HCP	LAB	INV	SME	PRO	ASSOC	POL
Stakeholder group	International Corporation	Healthcare provider	Lab	Investor	SME	Professional	Association	State policy

Perspectives (TP – technological p., OP – organisational p., PP – personal p.)	Trend 1 **AI in pre-diagnostic stage (chatbots)**		Trend 2 **AI during diagnostics (medical imagining)**		Trend 3 **AI in post-diagnostic stage (CDS)**	
	1st order consequence	2nd order consequence	1st order consequence	2nd order consequence	1st order consequence	2nd order consequence
TP	Medical applications using AI are developed (**1INC; 3HCP/LAB; 4INV; 10HCP/LAB; 13HCP/LAB**) *T.1.1. – 5*		Development of new means for diagnosis (**2INC; 4INV; 5SME; 13HCP/LAB**)		Potential implementation within the realm of bioinformatics (**2INC; 4INV; 5SME; 8INC; 10HCP/LAB**)	
TP	With new technologies doctors can now monitor patients' health remotely – telemedicine (**2INC; 4INV; 7INC; 13HCP/LAB**) *T.1.1 - 6*		Integration of AI In virtual microscopy (**1INC; 3HCP/LAB; 4INV; 7INC; 8INC; 10HCP/LAB;**) *T.2.1 - 1*		AI implemented in treatment of cancer tumours (**1INC; 2INC; 4INV; 7INC; 8INC; 10HCP/LAB; 11INC**)	
TP	Machines can substitute initial consultancy and check-ups normally conducted by assistance health care personnel (e.g. in cases by nurses) (**1INC; 2INC; 4INV; 5SME; 12POL/SME**) *T.1.1. - 7*		Diagnosis can be carried much faster (**1INC; 2INC; 4INV; 9SME; 13HCP/LAB**) *T.2.2 - 2*		Health and treatment-related information is stored in data banks (**3HCP/LAB; 4INV; 8INC; 12POL/SME**)	Cyber-security issues arise (**1INC; 4INV; 5SME; 7INC; 13HCP/LAB**)
TP	AI can be useful for the patient to evaluate initial symptoms (**1INC; 3HCP/LAB; 4INV; 5SME; 8INC; 9SME; 11INC; 12POL/SME**) *T.1.1. - 11*	More consumer centric medical appliances are developed (**1INC; 2INC; 3HCP/LAB; 4INV; 7INC; 8INC; 13HCP/LAB**)	Technology is prevalent on focusing mainly on one diagnosis aspect (**1INC; 3HCP/LAB; 4INV; 5SME; 7INC; 8INC; 10HCP/LAB; 11INC**) *T.2.1 - 8*	Additional health check-ups still required (**2INC; 4INV; 9SME; 10HCP/LAB; 11INC; 13HCP/LAB**)	Combination of AI and blockchain can provide enhanced security (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 7INC; 8INC; 9SME; 11INC**)	Information sensitivity becomes increasingly technology-dependant (**6PRO/ASSOC; 10HCP/LAB; 12 POL/SME; 13HCP/LAB**)/ Additional preventive controlling measures need to be developed (**2INC; 4INV; 7INC; 8INC; 9SME**)

TP	Developed AI-based applications are equipped with their own sets of data bases, algorithms, text recognition tools (**2INC; 3HCP/LAB; 6PRO/ASSOC; 9SME**) *T.1.1 - 16*	The end product is capable of result inference which provides better contextualisation (**1INC; 2INC; 6PRO/ASSOC; 7INC; 9 SME; 13HCP/LAB**)	Much of doctor's work is automated (**1INC; 3HCP/LAB; 4INV; 5SME; 7INC; 9SME; 10HCP/LAB; 11INC; 13HCP/LAB**) *T.2.1 – 9*			Limited time, usage and access systems are integrated to regulate consent measures (**4INV; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**) *P.3.2. - 10*
TP	AI software integrates User-generated Data into its assessments (**2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**) *T.1.1 -21*	The user is presented with rich data that extends from health-related aspects (e.g. purchasing behaviour, location tracking, etc.) (**3HCP/LAB; 6PRO/ASSOC; 7INC; 8INC; 9SME; 10HCP/LAB; 13HCP/LAB**)		Boost of scientific initiatives in the country leads to new technological advancements (**1INC; 2INC; 4INV; 8INC; 11INC**) *T.2.2 - 13*	Automatic clinical decision support systems are developed to assist patients in their health management (**6PRO/ASSOC; 8INC; 10HCP/LAB; 13HCP/LAB**)	AI software is integrated into CDS systems as a consultant tool (**1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 9SME**)
TP	Machines will not be able to take care of human-administered procedures like e.g. injections in a long time (more than 10 years) (**6PRO/ASSOC; 10HCP/LAB; 12POL/SME; 13HCP/LAB**) *T.1.1 - 23*	Non-invasive medical devices will become much more tech-efficient and widespread across population (e.g. wearables, hearing aid) (**1INC; 2INC; 6PRO/ASSOC; 10HCP/LAB; 13HCP/LAB**)	New information systems allow for almost constant (online) updates on patient's history (**2INC; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 11INC; 13HCP/LAB**) *T.2.1 - 19*	The AI systems are trained to evaluate all of the patient's history in short amount of time prior to conducting any diagnosis or analysis (**2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 9SME; 13HCP/LAB**)		Clinical Decision Support systems are integrated in the health record systems (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 13HCP/LAB**) *T.3.2 - 14*
TP	Chatbots are designed as a front-end tool for consultancy on the health-related matters (**1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 10HCP/LAB**) *T.1.1 - 24*	Users receive advice and guidance on health-related procedures without human contact (**2INC; 3HCP/LAB; 6PRO/ASSOC; 10HCP/LAB; 11INC**)	AI software excels in image and pattern recognition (**5SME; 6PRO/ASSOC; 9SME; 11INC**)	Interpretation of medical images (e.g. X-rays) gets streamlined (**5SME; 6PRO/ASSOC; 8INC; 12POL/SME**)		CDS interface is designed in a way that patient can be directly consulted by AI-based systems (**1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 10HCP/LAB; 13HCP/LAB**) *T.3.2 - 15*
TP	Voice-assistants powered by AI are integrated withing healthcare units (**6PRO/ASSOC; 9SME; 11INC; 12POL/SME; 13HCP/LAB**) *T.1.1 – 25*	Scheduling and other administrative matters can be handled by AI (**1INC; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB**)	New technologies are developed to diagnose previously unidentifiable health conditions (**1INC; 5SME; 6PRO/ASSOC; 8INC**) *T.2.1 - 22*	Impacts of rare diseases and genetic health conditions on the population are reduced (**1INC; 6PRO/ASSOC; 8INC**)	Fast Healthcare Interoperability Resources (FHIR) are set as a standard for information transfer, usage, and coding (**2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 9SME**)	The speed of technology adoption rate and overall integration across country is substantially increased (**5SME; 6PRO/ASSOC; 8INC; 12POL/SME**)

TP		Machines are personified and attributed human features to minimise "the uncanny valley effect" (**1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 9SME**) *T.1.2 - 26*	AI software works well on the narrow fields and specific cases (Artificial Narrow Intelligence is mainly integrated) (**2INC; 5SME; 7INC; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC**)	No generic machine learning in clinical medicine is developed in the near future (**6PRO/ASSOC; 12POL/SME**) / Multiple AI-supported systems are used and consulted at a single point of time (**2INC; 6PRO/ASSOC; 7INC; 8INC; 13HCP/LAB**)	AI supported systems can accurately estimate the baseline risk for the patient than any other tools (**1INC; 2INC; 5SME; 6PRO/ASSOC; 8INC**) *T.3.1 - 17*	
TP			AI-supported diagnostic systems are reliant on Internet connectivity (**1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 12POL/SME**)	Potential risks associated with connectivity problems and power shortages (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC**)	Machine-learning processes integrated within the CDS systems provide opportunity for feedback loops with the users (**2INC; 6PRO/ASSOC; 8INC; 9SME; 11INC**) *T.3.1 - 18*	The processes and results are constantly refined and improved (**1INC; 3HCP/LAB; 6PRO/ASSOC; 10HCP/LAB; 12POL/SME**)
TP			Genetic information is extracted and decoded at a much faster speed (**1INC; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 12POL/SME**) *T.2.1 - 29*	Genetic-related diseases are better evaluated, and new treatments are developed (**2INC; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB**)	Big data applications are not suitable for suggesting treatments based on the real-world data (**6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB**) *T.3.1 - 27*	
TP			Training – validating – testing loop of the AI-powered systems allows for constant improvement of the final diagnostic results (**2INC; 3HCP/LAB; 5SME; 7INC; 9SME; 10HCP/LAB; 11INC; 13HCP/LAB**) *T.2.1 - 35*	Depreciation costs of such technologies are markedly reduced (**1INC; 3HCP/LAB; 5SME; 9SME**)	Neural networks integrated within AI-based systems allow for branching decision support (**1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 13HCP/LAB**) *T.3.1 - 28*	The decision-making process is much more difficult to track (**2INC; 6PRO/ASSOC; 10HCP/LAB; 11INC**)
TP					Hereditary diseases which occur only at a certain stage of patient's life can be identified through predictive analytics (**5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**) *T.3.1 – 30*	Health condition of Finnish citizens can be better anticipated in the future, so proactive measures can be taken in advance (**2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 13HCP/LAB**)

TP					Big data combined with AI-powered CDS systems allow for more efficient treatment strategies of large groups of people (**2INC; 5SME: 6PRO/ASSOC; 10HCP/LAB; 11INC; 13HCP/LAB**) *T.3.1 - 32*	The baseline risks among population become easier identifiable (**3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC**) / Effective treatment methods can be generalised through similar cases across population (**1INC; 3HCP/LAB; 6PRO/ASSOC; 7INC**)
OP		AI interactions need to be classified and reflected in the "Terms and Conditions" (**2INC; 4INV; 5SME; 7INC; 8INC; 10HCP/LAB**) *O.1.2 – 5* / Apps developed with AI are compliant with General Data Protection Regulation (GDPR) rules (**1INC; 2INC; 8INC; 9SME; 11INC; 12POL/SME; 13HCP/LAB**) *O.1.2 - 5*		Allows for more decentralised care provision (**2INC; 3HCP/LAB; 4INV; 5SME; 7INC; 8INC; 12POL/SME; 13HCP/LAB**) *O.2.2 -1*	AI is not considered as a solution / does not provide add-on value (**3HCP/LAB; 4INV; 5SME; 8INC; 12POL/SME**)	Investments to the field of AI and machine-learning are redirected to other areas (**2INC; 3HCP/LAB; 5SME; 7INC**)
OP		Online or offline results can bear differences (**1INC; 4INV; 5SME; 7INC; 10HCP/LAB**) *O.1.2 - 5*	Development of quality requirements (**3HCP/LAB; 4INV; 5SME; 9SME; 10HCP/LAB**)	Consideration for application of relevant ISO certificates (**2INC; 4INV; 10HCP/LAB**)	AI software is challenging to validate on a regulatory level (**3HCP/LAB; 4INV; 9SME; 13HCP/LAB**) *O.3.1 - 3*	Ambiguity of responsible party in case of malfunction (**1INC; 3HCP/LAB; 4INV; 7INC**)
OP		Less doctors present for immediate help to patient (**2INC; 4INV; 7INC; 8INC; 11INC**) O.1.2 - 6		Longer queues in hospitals to get the necessary health monitoring (**4INV; 7INC; 10HCP/LAB; 12POL/SME; 13HCP/LAB**) *O.2.2 - 8*		Limiting the scope of AI implementation due to lack of competence base (**4INV; 5 SME; 7INC; 10HCP/LAB; 13HCP/LAB**) *O.3.2 -4*
OP		Healthcare assistance personnel is reduced in numbers (**2INC; 4INV; 5SME**) *O.2.2 – 7* / Role of nurses becomes more important in secondary healthcare (**1INC; 3HCP/LAB; 13HCP/LAB**) *O.2.2 – 7* + *O.2.2 - 36*	Huge corporations take advantage of supplying AI-based technologies (**4INV; 5SME 7INC; 8INC; 11INC; 13HCP/LAB**)	Local economy becomes dependent on international investment (**4INV; 5SME; 7INC**)	Government decides on the openness of the nation's health data (**1INC; 2INC; 4INV; 11INC**)	Finnish companies are the first to create new solutions (**4INV; 10HCP/LAB**) / International corporations dominate the market (**2INC; 5SME; 9SME**)

OP	New legislation allows for data-centred products to be created primarily within local start-ups (**2INC; 4INV; 3HCP/LAB; 5SME; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**)	International companies partner with domestic ones (**4INV; 7INC**) / Government issues new funding pools to support development of AI-software and applications on a national level (**1INC; 6PRO/ASSOC; 11INC; 13HCP/LAB**)	Finnish hospitals partner with big corporations (**2INC; 3HCP/LAB; 4INV; 7INC; 8INC; 10HCP/LAB; 11INC**)	Domestic start-ups are left behind (**1INC; 4INV; 7INC; 8INC; 10HCP/LAB; 13HCP/LAB**)	Substantial investments have already been made into building the open data access systems (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 8INC; 13HCP/LAB**) *O.3.1 - 12*	
OP	Health data banks and CDS systems can be accessed and used by third parties through APIs (**3HCP/LAB; 6PRO/ASSOC; 9SME; 10HCP/LAB**)	The research community benefits from the new pools of data (**2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 13HCP/LAB**) / Multiple NGOs emerge with different purposes (e.g. research / audit / consulting) (**6PRO/ASSOC; 8INC; 10HCP/LAB; 12POL/SME; 13HCP/LAB**) / Companies create tailored market offerings (**1INC; 2INC; 3HCP/LAB; 8INC; 10HCP/LAB; 11INC**)	The research and development of AI solutions is fostered through national health data banks (**1INC; 4INV; 7INC; 8INC; 11INC; 12POL/SME**) *O.2.1 - 13*	Local companies benefit from the insights and develop new market offers (**2INC; 3HCP/LAB; 4INV; 8INC; 13HCP/LAB**)	Government issues creation of health record systems across the country (**2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 8INC; 13HCP/LAB**) *O.3.1 - 14*	Multiple health records from various companies are created across different regions / hospitals (**3HCP/LAB; 6PRO/ASSOC; 8INC**)
OP		Multi-layered information allows for other industries to connect and provide their offers (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 12POL/SME**) *O.1.2 - 21*		Health-care system is transitioning towards online medium and real-time health care provision (**1INC; 2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB; 12POL/SME**) *O.2.2 – 19* / "The Virtual Hospital Initiative" gains more traction (**3HCP/LAB; 5SME; 8INC; 12POL/SME; 13HCP/LAB**) *O.2.2 – 19* / Waiting periods from analysis to treatment for the patients are extensively diminished (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 11INC**) *O.2.2 -19*	A "head" data repository for health-related information is established on a national level by the Ministry of Health – "Kanta" (**2INC; 5SME; 6PRO/ASSOC; 11INC**) *O.3.1. - 15*	Health information of citizens across the country in different organisations / hospitals can be partially traced through one system – "Kanta" (**1INC; 2INC; 5SME; 6PRO/ASSOC; 7INC; 11INC**)

OP		Workforce has time to prepare and adapt to the future changes in the industry (**1INC; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**) *O.1.2 - 23*	Genetic information of citizens is stored in the Finnish genome bank or in the Finnish Kanta archives (**5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**)	Special security mechanisms (e.g. differential privacy) are installed to monitor every single point of interaction with the genetic data by patient, clinician, or a 3rd party (**3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 13HCP/LAB**)		Stored information about (un-)successful treatment cases allow for hospitals to iterate and improve their operations with lower risks (**1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 13HCP/LAB**) *O.3.2 - 18*
OP		Switchboard, phone services, registration services are partially reduced or minimised in the hospitals (interchanged for chatbots services) (**1INC; 5SME; 6PRO/ASSOC; 7INC; 8INC; 13HCP/LAB**) *O.1.2 - 24*		Social Welfare and Health Care reform (SOTE) promotes the application of AI-powered technologies as a way to curb the gradual increase in the healthcare costs (**3HCP/LAB; 10HCP/LAB; 12POL/SME; 13HCP/LAB**) *O.2.2 - 35*		The usage of CDS systems extends to multiple stakeholders including researchers, specialists, private organisations and even patients (**1INC; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 13HCP/LAB**) *O.3.2 - 20*
OP		Management of medical personnel is improved (**3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 12POL/SME**) *O.1.2 - 25*	Supplied market offers with AI properties are scalable across the industry (**1INC; 2INC; 5SME; 7INC; 8INC; 9SME; 10HCP/LAB; 11INC; 12POL/SME**)	The providers of the AI-supported tech have higher ROI (**7INC; 9SME**) / Solutions offered across industry sectors are more adaptable to the changing needs and demands of the customers (**5SME; 7INC; 8INC; 9SME; 11INC**)		Design and administration methods of treatments and therapy remain more or less consistent in the near future (**1INC; 6PRO/ASSOC; 7INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**) *O.3.3 - 27*
OP	Cyberpsychology gains significance in mental health studies (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC**) *O.1.1 - 26*	Personnel is extensively trained and educated to maintain the digital side of the organisation (**1INC; 6PRO/ASSOC**) / Expenditures on change management in health care units increases (**2INC; 3HCP/LAB; 5SME; 7INC; 8INC; 9SME; 10HCP/LAB; 11INC**)			AI can be used as a means for a large-scale cyber-terrorism to jeopardise health-related information of the population (**2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 12POL/SME**)	Health of the population and national integrity are at risk (**1INC; 2INC; 6PRO/ASSOC; 10HCP/LAB; 13HCP/LAB**)

OP	AI supported health care assistant tools can be easily spread across the market (**3HCP/LAB; 6PRO/ASSOC; 5SME; 7INC; 8INC; 11INC; 12POL/SME; 13HCP/LAB**) *O.1.1 - 31*	Government has new means to tackle inequality of access to the healthcare among Finnish citizens (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 12POL/SME; 13HCP/LAB**)			Social Welfare and Health Care reform (SOTE) aims at focusing primary care provision under "one roof" strategy (**3HCP/LAB; 5SME; 7INC; 8INC; 11INC**)	Network of health care centres across the country will be narrowed down (**3HCP/LAB; 5SME; 7INC; 8INC**)
OP		Investments in primary care positively impact the health condition of the population (**2INC; 3HCP/LAB; 5SME; 7INC; 8INC; 10HCP/LAB; 11INC; 12POL/SME**) *O.1.2- 33*			Social Welfare and Health Care reform (SOTE) allows health care units across the country to be privately owned (**1INC; 3HCP/LAB; 7INC; 13HCP/LAB**)	Health organisations in Finland take advantage of both private and public funding (**1INC; 2INC; 3HCP/LAB**)
OP	Social Welfare and Health Care reform (SOTE) is increasing accessibility of primary medical services to the citizens (**2INC; 3HCP/LAB; 5SME; 7INC; 12POL/SME; 13HCP/LAB**) *O.1.1 - 34*					
PP	Widening the portfolio of competences among clinicians (**4INV; 7INC; 8INC**)	Supporting the career development of academics and clinicians (**2INC; 4INV; 7INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**)		Clinicians save time (**2INC; 3HCP/LAB; 4INV; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**) *P.2.2 -2* / Clinicians can provide a better diagnosis (**2INC; 3HCP/LAB; 4INV; 5SME; 8INC; 10HCP/LAB; 11INC; 12POL/SME**) *P.2.2 - 2*		More pressure on the doctors (**2INC; 4INV; 5SME; 7INC; 8INC; 11INC; 13HCP/LAB**) *P.3.2. - 3*
PP	Customers assess their health at home (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME**)	Customers become used to AI-powered interactions (**1INC; 3HCP/LAB; 4INV; 10HCP/LAB**) *P.1.2 - 5*		Patient can be misguided about his/her overall health quality (**2INC; 4INV; 8INC**) *P.2.2. - 8*	Clinicians lack competence to interact with AI systems (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 10HCP/LAB**) *P.3.1 - 4*	
PP		Less face to-face interactions between patient and doctor (**4INV; 7INC; 8INC**) *P.1.2 – 6*		Doctors become much more efficient in care provision (**4INV; 5SME; 7INC**) *T.2.2 - 9*	Citizens own their health data (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**)	Patient's health data is treated in the same way as IP (**1INC; 3HCP/LAB; 4INV**)

PP		Patients are gradually empowered in the matters regarding basic self-care (**1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 7INC**) *P.1.2 - 11*		Human factor is considerably reduced in the process of conducting a diagnosis / analysis of the patient's current health state (**2INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 10HCP/LAB**) *P.2.2 - 19*	Human factor in data related concerns of privacy and confidentiality (**3HCP/LAB; 4INV**)	Risks of data leaks, bribery, and other illegal activities (**3HCP/LAB; 4INV; 7INC; 9SME; 12POL/SME**)
PP		Users become better in the assessment of the potential condition they could be experiencing (**6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 12POL/SME**) *P.1.2 - 16*		Physicians are educated to use and implement new diagnostic technologies (**1INC; 6PRO/ASSOC; 7INC; 8INC**) *P.2.2 - 22*	Patients regulate the consent of their health-related data access to 3rd parties (**3HCP/LAB; 4INV; 5SME; 8INC; 12POL/SME**) *P.3.1 - 10*	
PP	Patients can better evaluate their personal needs within the health-care related matters (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC**)	Doctors' counselling and consultancy role is increased (**1INC; 5SME; 6PRO/ASSOC; 7INC**) / Doctors competences increase in the treatment of serios cases (**3HCP/LAB; 6PRO/ASSOC; 13HCP/LAB**)	Patients may choose AI tech to be implemented in the process of their diagnosis (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 10HCP/LAB; 11INC**)	Doctors transition between different ways of conducting diagnosis (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 8INC; 10HCP/LAB; 13HCP/LAB**)		Investors can ignore the moral and ethical concerns of health-data confidentiality (**1INC; 3HCP/LAB; 4INV; 8INC; 10HCP/LAB**) *P.3.2 - 12*
PP		Human interaction is still a necessity to update on chatbot's guidance to the patient (**3HCP/LAB; 6PRO/ASSOC; 11INC; 12POL/SME**) *P.1.2 – 24* / Call centres in medical organisations are reduced (**3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**) *P.1.2 - 24*	The AI-based diagnostic tool can be hacked (**3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 12POL/SME**)	Sensitive information can be utilised with malevolent intentions (**2INC; 5SME; 6PRO/ASSOC; 10HCP/LAB**) / Clinicians can be wrongly accused of illegal activity associated with patients' data (**5SME; 6PRO/ASSOC; 12POL/SME**)		Citizens can control their health-related information (**1INC; 3HCP/LAB; 6PRO/ASSOC; 8INC; 11INC; 12POL/SME; 13HCP/LAB**) *P.3.2 - 15*
PP		Human-to-Human Interaction is complemented by Human-to-Computer Interaction (**1INC; 6PRO/ASSOC; 7INC; 8INC; 11INC; 12POL/SME; 13HCP/LAB**) *P.1.2 - 25*	AI software can malfunction or develop misinterpreting results (**1INC; 2INC; 3HCP/LAB; 6PRO/ASSOC; 7INC; 11INC; 13HCP/LAB**)	Patient's current and future health are at risk (**1INC; 2INC; 3HCP/LAB; 6PRO/ASSOC; 12POL/SME; 13HCP/LAB**)/ Challenges in the identification of the responsible party to be held accountable for (**1INC; 2INC; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 13HCP/LAB**)		Doctors gain access to richer information about the patient (e.g. drug intake / response / conditioning) (**1INC; 5SME; 6PRO/ASSOC; 11INC**) *P.3.2 - 17*

PP		Patients can recognise difference between computer-aided medical provision vs human-administered (**2INC; 5SME; 6PRO/ASSOC; 7INC; 10HCP/LAB**) *P.1.2 – 26* / The difference between computer aided vs human aided help is virtually unrecognisable (**3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 9SME; 12POL/SME; 10HCP/LAB**) *P.1.2 - 26*		By cross-referencing across different systems utilising anonymous genetic data, patient's personal information can still be retrieved (**3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 11INC; 13HCP/LAB**) *P.2.2 - 29*		Doctors participate in the training of machine-learning systems and provide the necessary human judgement (**1INC; 2INC; 6PRO/ASSOC; 7INC; 8INC; 11INC; 13HCP/LAB**) *P.3.2 - 18*
PP	Citizens can become overly reliant on self-treatment through consulting with AI systems (**2INC; 6PRO/ASSOC; 8INC; 11INC**)	Increasing risk of home incidents due to incorrect self-administered treatments (**2INC; 5SME; 6PRO/ASSOC; 7INC; 8INC**)			CDS systems are mainly developed by physicians and IT specialists (**2INC; 5SME; 6PRO/ASSOC; 7INC; 13HCP/LAB**) *P.3.1 - 20*	The upkeep and control of the systems are revolved around physicians and IT specialists (**2INC; 3HCP/LAB; 6PRO/ASSOC**)
PP	Users can consult AI-supervised systems during any hour of the day (**1INC; 3HCP/LAB; 5SME; 9SME; 11INC**) *P.1.1 - 36*	Citizens benefit from closer and faster access to the basic health care support (**3HCP/LAB; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 13HCP/LAB**) *P.1.2 – 31 + P.1.2 - 34*				Physicians consider more factors when choosing suggested course of therapy for the patient (**1INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 7INC; 8INC; 10HCP/LAB; 13HCP/LAB**) *P.3.2 – 28*

PP	Citizens are granted tools to better assess and develop their health-related habits (**1INC; 2INC; 3HCP/LAB; 7INC; 8INC; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB**) *P.1.1 - 33*	Self-monitored health data is heavily biased (**2INC; 3HCP/LAB; 5SME; 8INC; 10HCP/LAB; 11INC**)				Patients evaluate the necessity of retrieving health-related information in the present moment that could bear the future consequences to their health (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC**) *P.3.2 – 30* / Major shifts in the paradigm of life planning (**2INC; 3HCP/LAB; 5SME; 6PRO/ASSOC; 11INC**) *P.3.2 - 30* / Imbalance of power between citizens and industry professionals in access to the genetic information that bears future consequences (**1INC; 3HCP/LAB; 6PRO/ASSOC; 11INC**) *P.3.2 - 30*
PP						Clinicians can make better prognosis of treatment efficacy for each and every patient (**1INC; 6PRO/ASSOC; 10HCP/LAB; 12POL/SME**) *P.3.2 - 32*

Appendix 2. List of interview questions

Introduction
1. *Could you please tell me a little bit more about your company, your field and your current occupation?*

Current technologies
2. In your experience, can you name some of the latest technologies that you have been involved working with?
3. Have you currently encountered the integration of AI solutions in the sphere of your operations?

Future technologies
4. According to your professional opinion, what kind of benefits and opportunities opens up automation for operations in preventive health care?
5. When speaking about companies and patients, how do you think each of those parties will benefit from AI-solutions? What additional customer value will be created?

Organizational impact
6. How do you see the future role of the care provider (e.g. doctor) and the company in the treatment of diseases? Will there be a change in professional roles or management?

Concerns and threats
7. What are the potential concerns and challenges emerging from AI integration?

Impact on primary care:
8. What factors would influence the development of AI-based solutions in the area of primary health care in Finland? What parties should take action to influence that development – government, funds, NGOs?
9. Which areas of preventive health care will be most strongly affected by AI disruption, according to your opinion?

Conclusion:
10. *How are you preparing for the upcoming disruptive changes? How are you looking forward to embracing the upcoming changes?*

Appendix 3. Interview invitation letter

Dear (Recipient),

Greetings!

My name is Kirill Anton, I am an International Business student at the JAMK University of Applied Sciences. As part of the bachelor's thesis in business administration, I am intending to conduct research on the topic of Artificial Intelligence and its implementation in the area of Finnish preventive health care.

As far as I am concerned, you are a recognised expert in the industry of healthcare which makes me very enthusiastic to connect with you. Therefore, I would like to humbly ask, if it would be possible to conduct an interview with you where I could ask questions related to the research under investigation. The research is scheduled to take about an hour and will be recorded.

Driven by the factors that Finnish healthcare system is one of the world’s most recognized for its quality and technological-intensity with AI being the most disruptive and relevant technology in the industry at present-day, I believe that the interview with you will be of very high value to my research.

Thank you for your consideration!
I will be very interested to hear your opinion and will be looking forward to connecting with you again.

Respectfully,
Kirill Anton
International Business Student at JAMK UAS
Tel. (number)

Appendix 4. Example of edited interview transcript from the dataset

Interview with one of the Research Participants from the Sample

Interviewee: (1INC; 2INC; 3HCP/LAB; 4INV; 5SME; 6PRO/ASSOC; 7INC; 8INC; 9SME; 10HCP/LAB; 11INC; 12POL/SME; 13HCP/LAB)
Date: (February/March/April/June 2018)
Interviewer: Kirill Anton
Place: (Jyväskylä/Helsinki/Kuopio/Tampere)
Length of the interview: around an hour

Interviewer: The recording has now started. So, I have looked a little bit through the *** and global website initiative and scanned through the current projects and I have noticed some of the AI projects that you are involved with, but I would like to hear from you a little bit more about this initiative, about its goals, what is it all about.

Interviewee: Well, the *** as such is not just a local programme, even though we have the Finnish entity in here, but this entity is part of the global network of *** programmes. So, we follow the same rules and principles and constants as *** has initially requested and we have been evaluated and accredited by the *** and the management. I was also personally already (before we even applied) invited to be *** because they wanted to conceptualize it more and also now I am currently a member of *** which might be the most difficult area in the whole development and evolution of these industries related to health-tech and life sciences. So, my major goal is to ***. There are many different other goals – supporting the *** and so, this is also widening the portfolio of competencies to form new kinds of compositions in the industry and so on. Another aspect is ***. So, ***. There are multiple ***, it depends so much on whom do you ask. At the end of the day when you ask patients, patients want to have better solutions, better care and better health and all these solutions that we are working with our targeted to do that or improve the industry to produce better solutions and better drugs, better treatment, better diagnostics and so on. So, getting back to ***.

Interviewer: So, it is wrong to assume that ***?

Interviewee: Yes, correctly. We are not ***. *** What could be achieved within such timeframes. ***.

Interviewer: So, you ***?

Interviewee: We breach the gap and also, we ***, however, we are not the only ones who do such things. And that is the first important element, the second – is that ***. We ***. Getting back to the goals, one of the big goals is ***. There are also different kinds of arrangements depending on the ***. ***. One more service that we provide *** is ***. What does it mean? It means that *** them this opportunity.

Interviewer: Thank you very much for sharing a little bit more commentary on that aspect. At first, I got a little bit different impression of what *** is all about, I misinterpreted it for ***, but now I see this ***. According to what I have already found in the industry when it comes to the tech developers in the industry of the preventive

health care, people who are able to develop certain kind of mindset, business approach, intuition are able to develop the solutions and implement them. I have recently met representatives of Tampere University who develop graphic processing units and they demonstrated a marvellously-sound technological presentation of their new solution during the yesterday conference AI Helsinki, but the unfortunate outcome from their words is that they do not particularly know where to apply it, don't know whom to serve it to, whom to talk with and the conference speakers described in more detail this major challenge in the industry – and it is a pleasure for me to ***.

Interviewee: I could maybe comment a little bit on that as well. This is a reality – when we are ***, the number one *** the clinical unmet need: *** the novelty aspect, it has to be novel. However, novelty does not necessarily mean that it should be novel science, it could be a novel paradigm. I will give an example – if you have been treating disease in a specific way with certain pharmaceuticals, you have a new paradigm with treating that disease with transplantation.

Interviewer: Different approach…

Interviewee: So, it is a different approach, a different paradigm for making the solution. So, we are ***. In many cases, there are already many clinical and pharmaceutical solutions that have been in use for more than 20 years into specific indication and that they have been patenting that usage and maybe, that patent has already expired, but we discovered that this molecule can be used to in the treatment of different indication and it could be refined and applied the patent for a new indication maybe "remodified construct or whatever it is". These are ***. Big pharma ***. *** can tap on very rare diseases and even not depending on the number of patients, the treatment itself can be very costly, hundreds of thousands of euros a year, but still, the drug can be very poor or ***. These are kind of consequences that ***. Maybe I would also like to conclude that – especially here in Finland, we are *** these are the goals that we are putting into ***. So, maturity has to be ***.

Interviewer: And as I can see, you *** with no ***, according to your website. I wanted to ask…

Interviewee: I can tell you the numbers. So, we currently have ***.

Interviewer: And you have said that the timeframe would be ***?

Interviewee: *** is typical, at max ***. But it is so, that we communicate ***.

Interviewer: Thank you for the extensive introduction, if you do not mind, then we will move to a more contextual part of our interview. According to what you have mentioned, you have a diverse ***. Just one last question about the introduction – can you name some of the latest technologies that you have been involved working and operating with as part of ***? Not necessarily Artificial Intelligence, any new technologies, diagnostics or …?

Interviewee: Well, I am personally involved with ***. Basically, this is the space when you are talking about Artificial Intelligence, this kind of tools and they are a different kind of. In *** we also have some AI-related projects, and we have 2 more to come. You can already see ***, there is ***. *** I think that Artificial Intelligence is a nice

"buzz-word", but I wouldn't say that it is a solution. AI is not as such as we think it is "Intelligence" – I am not sure whether it is really Intelligence form or this is some form of setup algorithms and that's that the algorithms how we actually manage and utilize the data.

Interviewer: My next question would be – Have you encountered already the integration of AI in your sphere of operations? – and you have already answered that. So, we move to the next question. You might know that there are 3 academically known levels of Artificial Intelligence – Narrow, General and Superior. Narrow being for specific cases, diagnosis, prevention, pick-pointing certain aspects and tailor solutions based on that, then General Intelligence, that combines aspects of different spheres into one to develop a one, encompassing solution which is a very rare case and then the Superior Intelligence, that is an all-knowing mind, capable of self-reasoning which is mostly part of utopian science. And we are currently mostly speaking about the era of ANIs with major cases of AI-based solution developed for specific disease treatment. According to your website, you are partnering with ***, who develop the technology to treat *** tumours and the supply the system with extracted data how these tumours can be further identified and in the following cases, the software matches the data and looks if it is the same or not. The samples could drastically differ from one another, so they also enable a cloud computation to the software plus they provide the web microscope technology. And I wanted to ask, according to your professional opinion, what would be the benefits and opportunities AI technologies can bring in the operations of healthcare, especially in the area of primary, preventive health care.

Interviewee: I think these are the game changes in making the diagnosis. The work that clinicians or lab people need to do manually, and it might take some kind of months of work to look for very precise pictures or quantifiable calculations of the diagnosis, let's say pathological cells and so. Let's say, the problem is that it's very time-consuming, it requires a specific kind of people to do that type of work. So, if we have this kind of methods like *** have produced, it helps to split up the project or the task so it could be done in even minutes or seconds – the same work that would require months of work from the human being and it would be even more precise. The challenge is there – when we are talking about the clinical world and the regulators are requiring that you have to meet certain criteria of medical device, the software can also be a medical device, so the question is what are the requirements that your solution is clinically validated and it is also the question of responsibility. You know, if it does malfunction or misdiagnoses, who then will be responsible. If you look for the example at IBM Watson, what I am about to ask and maybe what you should ask is – what kind of quality certificates they have as a medical device?

Interviewer: Yes, definitely a reasonable question to ask when speaking about the future application of these technologies. Especially right now the debate is whether the doctor should take the responsibility for the malfunction of the programme that he/she uses or the company who developed that kind of software. The consensus seems far to be reached.

Interviewee: The problem is that – have you asked from the IBM Watson what kind of health-related certificates they have?

Interviewer: Unfortunately, I didn't have a chance to be in touch with the company.

Interviewee: That is maybe the most crucial thing to ask. Even though they are bold and beautiful, and they are big and have references and connections of many kinds, but when coming really in the clinical world, who takes the responsibility and how it is clinically validated, the solution. This is the question you should ask from every single vendor, every single, also from the bold and the beautiful and you might get very interesting responses on that.

Interviewer: *** who brought up the legal challenge of application of these technologies.

Interviewee: If you think about going to the United States to the hospital, I bet that the lawyers will be looking for your kind of head on the plate if the system doesn't work. So, this is the kind of fundamental question that should be set for every single entity – so what kind of quality requirements should be set for all of these programmes, whether we call them Artificial Intelligence programmes or whatever you want to call it – decision support systems. So, what I am emphasizing, that there is a huge need to dig deeper in that kind of issue. If these requirements are set for small and medium-sized companies so that they have to meet the quality system requirements so that they have to have ISO 13845 or 13485 associated certificate. So, it has to be the same for all of these entities, so bold and beautiful, all of the big companies have to meet the requirements and so on. Then we come into the discussion into playing that this is not a diagnostic tool kind of you know support system, but at the end of the day, you are offering some guidance for the decision making so we come back to the clinicians who are going to utilize the solution. How on earth clinician has any opportunities to evaluate the validity of the guidance that the system is providing, because they don't know how it operates, they do not know the algorithms that are utilized there and where the problems might occur and so on. So, transferring the responsibility for the clinician who is using the solution, it really has to be clearly stated and the clinicians really have to understand where are the limitations of the solutions, also where are the legal limitations or where are the limits in the legal aspect. For example, if you have a drug that you are using for the treatment for the patients, they have to meet very, very strict requirements by the FDA or the European Drug regulations. So this is one of the things, it is like the "Wild West" at the present moment without a not very clear understanding and clear directions how to regulate these solutions and most kinds of you know the striking and dangerous issue is "app". "App-type" of the world in which we need to take into consideration the very fracture of the mobile device, will it be an Apple product and so on. Actually, has Apple validated the device that it is a medical device because if you are running an application on top of that, who is taking the responsibility if there is a malfunction.

Interviewer: Actually, I know remember what some people have answered about the issue of requirements and legal actions. Occasionally, companies try to circumvent this issue and not necessarily dig down too deep into the field of legal requirements. There are multiple ways of pivoting, for example, instead of using the legal certificates, proclaiming that "the usage of the software will not necessarily provide you with valid results and you should not trust the software results over the doctor's final statements". So, this is one of the ways to deal with potential malfunctions by saying that you should not over-rely on the technology. Of course, such approach is not profoundly accredited, it is just the way to try to test the solution on the market before attaining a wider customer base, but it is definitely necessary to have requirements like FDAs to create an operational field for these technologies.

Interviewee: Since this medicine is becoming more consumer-centric and solutions are becoming more consumer-centric, their issues need to be discussed immediately, the earlier than later, because it also becomes the question – if the people are measuring their own health at home, who is then responsible for the measurement conducted in a right way, on the right spot and so on. It becomes very unclear – in this "app-world" also you frequently get these new kinds of updates – "customer used the software without the latest update installed, so we are not taking responsibility for that actions". So, it becomes a messy, very-very messy area in which we need to clarify this situation also in that sense if we are providing *** so it really works. Even there are disclaimers, that this is not a diagnostic tool doing open diagnostics, but at the end of the day, depending on if there are 150 pages of disclaimers on, so the question is that consumer has no competences to understand what these disclaimers really mean. So, we might end in the situation so that what is the justified expectation from customer to consumer to find the benefit or the solution or to expect how efficient it is. I am a little bit sceptical on that until the regulator really starts putting some guidelines and requirements for this, it becomes even wider than it is at the moment and it is a scary thing. Even though some optimists are saying that this is revolutionary, it is going to revolutionize everything, but I am kind of 100% sure that it is also doing a lot of damage, is also becoming a cyber-problem. The cyber-security problem, the more we have this kind of applications and in our own mobile devices and so on, and even this information goes to some data banks and so on, so it could be also a very nice target for criminals to start using those applications to get into this system through data banks and repositories and using them for their own purposes. This kind of aspects needs to be taken into account.

Interviewer: Of course, definitely. I was about to ask about potential challenges further in our interview, but I am very grateful that you brought this topic first on the table. It is very-very important, and the issue of data security, especially when we are concerning the Hippocratic oath, that the data will not be transferred between the doctor and the patient. In the realm of the 4th Industrial Revolution, the Hippocratic oath is seized to exist – because even though your data should be anonymous, any third-party could have a right to get access to it. So, the oath won't function as it is anymore because the data will be available for any other company who wants to provide the service, any other illegal company as well. In these senses, we will see changes not only in a technological perspective but also from the role management aspect. Do you see anyhow altering the reality of the responsibilities of the doctor to consumer-relationships, to patients? In the light of the AI technologies, will the doctor be more involved, less involved in the discussion and communication with the patient and actual provision of it? Or will it remain more or less the same as it is today?

Interviewee: Well, it is not kind of you to know, more or less, because it is very dependent on what is the goal and what are the solutions. I'll give you an example, new technologies allow doctors to participate in the chronic disease management more than previously because now you can take measurements every single day at home and then it downloads in the databank and the doctor can see or there can be some kind of warning signs, if numbers are beyond this, it will you give you a warning sign if there are any problems. So, it can automate a lot of things, so this enables the doctor to participate more in chronic disease management, for example, this way. Also, at the same time many times, it has been so that the doctors have all been controlling, for example, drug usage and based on the kind of so, they want to see the patient face-to-face and so on. Now it may be so that there are much fewer times when the doctor needs to see the patient, and it is just that there are all the numbers on the screen and it raises the question if it is appropriate or not. It might also lead to the situation when the doctor

is not able to validate and needs to ask from the patient “have you been taking those pills every single day, drugs? How is your nutrition? Has it been changing?”. As we know, the nutrition and the daytime when you take the drug can have a huge impact on how it works in your system, so double-checking this kind of things might be less and this kind of measurements. So, it might cause more problems for the patient, because there is less this kind do interaction as such.

Interviewer: Less psychological comfort?

Interviewee: Yes, and also the control. Let’s say the understanding, the system should start doing the same kind of questions as the doctor does when he tries to estimate what kind of things need to be changed, need to increase the amount of the dosage or change the diet or change the time of the day when you take the drug. It is a problem – it might decrease the needed amount of contact with the doctor, because we start believing so that is the solution, so we trust the numbers, blood, sugar, so we can see what happens. Necessarily it doesn’t work at all, there is no making more or less this management opportunities for management of this chronic diseases, sometimes it is very very good, and sometimes it can create obstacles or chasms between the patient and the doctor, because we start relying on the technology, so that it is solving the problems all day, so it is solving all problems and replacing this face-to-face contacts and discussions between the doctor and the patient.

Interviewer: Recently, I had a chance to get acquainted with a doctoral thesis on the effect of psychological stress in the medical corporation and treatment on the life expectancy of people under treatment during 7 years and the sample of the research was around 1000 people – who received a very direct, straight forward medical approach from the doctor without any kind of involvement in the situation (almost in a cold, harsh way) and the other research group was affected by a more involved, indirect approach from the doctors. The results show that the curve after one year tremendously altered – so the life expectancy of the first group, after 1 year decreased tremendously while the other group added 2-3 years plus to their expected life length.

Interviewee: So, which one increased and which one decreased?

Interviewer: The ones who were subject to more psychological stress decreased their expectancy due to the straightforwardness of the medical approach they received, while the other who were more engaged, happier and more satisfied, health conditions and mental conditions continued to improve which helped to support the overall positive effect. The study also circumvented the effect of placebo, so it ensured that people did not overthink on themselves, so the approach and procedure was identical in both cases, but the attitude differed, the one was more straight-forward, while the other was more inclined towards the patient. The approaches were repetitive, there were no any alterings to the process, so I would say that discussion is that – in some countries, there is a debate, there would not be the need for nurses anymore as their main function is to diagnose and to address the patient need before transferring him to the doctor for the treatment. The most amount of functions of nurse occupation except maybe for psychological factor and the actual physical contact in the form of injections can be done by machines already now and this study shows that we ***.

Interviewee: Actually you are answering the same thing, you know where there are so many cuttings on face-to-face meetings because we rely on the technology so much or

we think that technology takes into account all the required aspects. Typically, it doesn't. I'll give you an example – may be in the 1980s in 1990s, we relied almost blindly on the ECG from the heart, the electrical functioning of the heart. So that ECG as a diagnostic tool was almost superior to all the other at that time. Then the ultrasound came during the 1990s, started to gain a little bit more and more through the technical development and then when we came into this millennia, ultrasound has gained much more you know positioning in the cardiology than ECG. But going back to ECG era, what kind of problem it treated, because, at the end of the day, the electrical system of the heart is like measuring the horsepower of the engine, but does the horsepower tell anything about data ergonomics and the actual functioning of the human, of the engine? The whole dynamic element of the heart and all those elements; also, the sounds of the other side problems, you just can't even detect by ECG. So, people have been spending hundreds of millions of dollars, even today, even billions on developing better and better ECG devices, cheaper, more sensors, smaller size, automated all thing, etc. But the basic fundamental element- the electric cardiogram tool for diagnosing the dynamic elements and the other elements of the human heart it cannot even touch it. Listening by using the audio-meter, measuring the decibels and using it for measuring the litres, the volume, where are measuring the volume, but the audiometer is measuring the voice and the soundwaves, not the volume as it is in the water. The device is not actually – it is very useful in a very-very narrow area when treating the heart and we relied very much on that in the 1970s, 1980s and even in the 1990s and started decreasing only until this millennium. Still, I can't believe that *** and all of these organisations *** more and more money into ECG development despite its huge shortcomings as a diagnostic tool. Cardiologists at the moment are almost refusing to utilize the ECG as a kind of diagnostic tool and use it only in a very kind specific problem when you need to measure the kind of you know electrical malfunction in the heart, but if you have a valve problem you can't see it, or any other problems or thickening of the heart muscle, you can't use it. It is a very-very narrow working solution, even fundamental science behind it can't change it. So, when you are using this kind of devices, you have to understand the limitations that they have.

Interviewer: And the big picture…

Interviewee: And now, the problem is – why on earth people *** more money into ECG development, because the fundamental technological physical phenomenon is what it is – it can't change it. Even though you get more precise and efficient analytics from that, but it only scans the electronic functioning of the heart and it does tell only that, nothing else, nothing more, because it cannot do anything more.

Interviewer: So, you do support ***? Quantitative is associated more with the improvement of the efficiency, size, the actual outcome of the final picture the solution can provide without tapping in any other areas. On the other hand, the qualitative approach for *** instead (in the example of solutions for cardiovascular diseases) can detect more areas for identification and further treatment.

Interviewee: I'll you give you a further example as an answer to that – let's go to the ultrasound. Ultrasound devices during the past 25 years decreased by size to the size that they can fit into your pocket, but the major problem with utilizing these ultrasounds – is that it is always a cardiologist tool, so it is dependent on the cardiologist to use it. At the end of the day, if they are more automated, some kind of you know, flows are going to the heart and how the valves are operating and so, it still requires a cardiologist to make an overall assessment of that. So, now there are huge queues for the

cardiologists at the moment, there can be even months-long queues, does it solve the problem, so that we have a very limited number of cardiologists that we instead decrease the size of ultrasound devices or that we bring more automated analytics into that. Does it really solve the problem of having those queues or having this mass-type in preventive medicine or this primary care having this kind of solutions? At the moment, not at all! It is just decreasing the size of the ultrasound device and bringing a little bit more automated diagnostics into that, but at the end of the day, always the diagnostics have to be done by the cardiologists. If, for example in Mozambique, there are only 5 cardiologists, it does not help at all to the situation in Mozambique, the only thing that they can maybe buy cheaper these ultrasound devices for these 5 cardiologists. So, it does not change the paradigm of making the ultrasound diagnostics and I just want to emphasize my example, so these are the same things as Artificial Intelligence. So we need to understand exactly so what is the solution to the actual problem we are solving – what is this AI solution for? Does it really speed up that process, does it really solve that problem that we have? The problem for example with the patient flows or with making the diagnosis, like *** solution, really makes sense as it can automate the human work that is very boring, long-time taking, repetitive and so on, and shrink that one month work and even more work into let's say 15 seconds. That's the beauty of that – it improves the process and the productivity of the process, it improves the diagnosis already at the point of care, but in point, it could take up to one month.

Interviewer: Great discussion, thank you for bringing up these controversial examples. It is great that we are moving back and forth from the negative and positive sides of the issue. My next question is exactly about what we've discussed – What factors would influence the development of AI solutions in Finland? What kind of parties should be more involved in order to foster this development and adoption of the technology? We already spoke about regulations – does it mean that the government should be involved heavily? How do you measure the expected required level of governmental involvement?

Interviewee: I would bring one more aspect into the discussion because it is the economic impact. When we are talking about developing the Artificial Intelligence solutions or utilizing these databanks and so, what I am most concerned is that it becomes a turf only for the big companies because they have all the resources they can give to provide tens of thousands, hundred thousand for hospitals. If you are a clinician of a clinical scientist at the hospital, you are happy to receive 200€ donation or grant from the industry and on top of that, you can apply for the government funding for that. So, the small start-ups, they do not have that kind of money, they do not have the privilege. So, what does it mean, is that these multinationals actually start to dominate the market and they actually are utilizing all these advancement and opportunities that these databanks are opening and this digital data is providing? A government should make a clear decision – it has a huge economic value so that it is actually a national asset so that our digital information is not open for all, it is an asset – national asset. It is a crown jewel of our nation, it is from our people from Finland, our data which is for me. It should not be open for everyone as such so that we have to take into consideration that we should mostly promote so that we could build new companies of our own that are developing the new solutions, the new algorithms and so on. Then, the big companies can acquire those – I'd rather see this kind of development, because of we don't do this way, it might be so that we might be lacking the start-ups, which are based from here which are developing new solutions and from that perspective, we are not gaining economic impact from that. The big companies are actually coming here, donating here maybe some hundreds of thousands of euros, the huge amount of data

and utilize it for their benefit and they leave nothing else. It's like banana states, we are calling them, it's like a raw material they come to get from here and they kind of process it and they selling the end result 10 thousand times of the value to us back. We need to take into consideration that the government needs to start controlling more about that so that we provide the privileges for the Finnish start-ups to utilize Finnish data for building these algorithms and so on, and then let the big companies buy these companies if they want to. That is the reality I would support doing. So they just do not provide data as a free gift to everybody, because, at the end of the day, it leads to the situation where is the economic impact, this crown jewel, the data of us, Finns! If I make a painting that can be put on the wall and if I write a script, if I design a new device, I have IP on that – others can't use that. If you have data about my health, who owns the IP? Do I own my IP? Why? If I write the poem, I own it, if I write the book, I own it, but why I don't own my IP, the IP on my data? Why? If you produce a song, you own it. If you produce a book, if you produce a poem, if you produce paint, if you produce a device, you own it. If I don't own my IP, IP to my health data and my all other related data, we are in very-very big problems, because it is about me, I am a person, a human being. If my genome has been sequenced, I don't want to give it for free to anybody, because nobody wants to give their music or poems or… you just can't jeopardize. Some associations produce music, there are huge global associations that are "guardian angels", so no one can jeopardize and use the musicians' rights. This is what we also have to do. We have to reconsider the whole paradigm so that we can make a deal with the industry, so if we are providing the solution for the big industries, if they are utilizing this data, they will pay for the data for the eternity, because they are utilizing our IP.

Interviewer: So, even though they are willing to provide a service on top of the IP, they shouldn't pay first and then wait for the customers to pay them back?

Interviewee: If the TV show plays a song, you have to pay for every single time you play the song in the form of royalty. If you make copies of the book, you have to pay the royalty, every time you make a copy, that's how it operates, the copyright. This is a lunatic situation – think about yourself. Would you like to own the IP to your health data because it is from you?

Interviewer: Yes. Actually, speaking about the approach of the Finnish government and the governmental papers they have published, they said that this national databank, the main goal behind its creation is to encourage small and medium-sized enterprises and start-ups to tap into the potential economy. So, they open first for these and after that they open for others big, multinational corporations. So, this kind of approach, hopefully, might be similar to the one that Israel wants to carry out, but it still requires further development and approval or regulations.

Interviewee: Going to the hospitals, any university hospital in Finland, look whom they are partnering with, they are all big boys and big girls. They have the privilege, not the start-ups. We are now building more barriers for the start-ups by kind of also making them pay upfront fees for becoming the partner and starting a new project, new protocols and so on. That is prohibiting building the value of our crown jewel.

Interviewer: Maybe social and health care reform will bring some changes – the structure changes and the roles entities play will change in 2020.

Interviewee: Could be, but I am a little bit sceptical at the moment because this is based on the university hospitals and big municipalities, university hospitals, they love this big boys and girls coming and donating 200 thousand money and do that we have access to your information systems and data banks and so on. By that, they kind of suck every single detail from there and guess what, once they have received it, it's gone. What is the upside in the future for them? The only upside is the new information that is coming on top of what they already get.

Interviewer: Definitely…

Interviewee: We have to rethink so that we are able to really rebuild the system that is enabling the increase of value the data-based solution within our start-ups. If the big boys and big girls want to buy them, they have to pay for that increase in the maturity of these solutions. And that's the way. Israel is doing in the technology side – they give the privileges for their start-ups or they build the knowledge within the Israel army, air force or anywhere and then they build the solution and the big boys and girls can buy the solution. There has to be very.., this is a scary thing that most of the people who make the decisions don't penetrate and concentrate their attention to this and once they have the green button to release the data, it's gone. You can't get it back anymore. It's like jumping from the aeroplane, once you have released – jumped – there is no way back.

Interviewer: So, should we think about imaginative lever that would control the access flow – now you have the access, now you don't?

Interviewee: The government can make it so, that for example, the big companies, multi-nationals can partner with small companies that are building the solution for them – that's the way, that's one way. So that we do not allow them, or we can allow the sandbox type of approach – so you dig, and bring any other type of material, any other information that is only specific, anonymous to the original data source. This kind of systems would be possible – and I have already ***.

Interviewer: Maybe blockchain can play its role in this case.

Interviewee: I do not want to talk about the technological part of the solutions. Blockchain is once again a technical kind of a buzzword, but the beauty is about not only using the blockchain but who to build the whole system so that it makes sense. I give you another example – when we are talking about Artificial Intelligence and so on, we think that security problem is in the technology, security problem is not the technology, the biggest security problem is the human being. For example, in Norway, there was an event just recently when health data of 5 million people were released into a completely wrong place by a human being. Or if you think about here, how many there have been news that doctors and nurses have been looking into health records of very famous people without any kind of patient relationship. So, having this kind of Kanta data pool is very kind of dangerous to have very kind of strict limitations and restricted freedom to access the data, because that allows the utilizing of the human-related risk by the criminals, for example, if somebody pays to someone to go kind of there and take the information that we like and then they kind of retire for the rest of their lives. What to do?

Interviewer: I just brought up the example of blockchain that it could be the basis of the system.

Interviewee: It is one of the technical opportunities, but we still need to understand so the blockchain can do something to secure, but the blockchain does not solve the problem, the human problem. We need to have to kind of rethink that blockchain can do some kind of technical solutions, but it does not solve, and we have to also solve that. And now technology can help us also solve that solution. As I have told you, I have been ***, but these are the elements that need to be taken into consideration. Now we have a child-like belief in the national data bank – is good for everybody. Now one of the leaders of the ***, he was among the first ones to announce that he believes that Kanta is more of a problem than a solution because of this situation so that it can be jeopardizing the security of all of us in Finland.

Interviewer: Yet again, not the Kanta is the problem, the potential misuse of the software is the problem.

Interviewee: But the Kanta does not have any kind of elements to prohibit the kind of misuse.

Interviewer: So, what if there will be a sum of profound regulations to the data protection, we will own the IP rights to our health data and we won't publish it for anyone except for special arrangements and via disclosures, yet controlled by the government who would use this kind of a lever model to open access and retrieve the access without allowing those big corporations the possibility to copy it or anyhow multiply it. Wouldn't it be a path to a solution?

Interviewee: You can do the screen share, or you can do the screencast, you can download it, you can take the screenshot. What I am emphasizing is that there always needs to be consent with the patient that I allow you to see my data or some kind of code. It is not open for all healthcare professionals, it is consent-based. I give consent because I believe that I should own the IP for my data, so I give a consent for you to utilize my data, not anybody else. And I give you the access only for a specific time, when I am having this problem, so you can see. Otherwise, you are not able to go there.

Interviewer: Yes, of course, it is a huge deal to prevent screencasting, etc, but what if we prohibit screencasting, screen sharing without the patient concern as an illegal action?

Interviewee: That's a problem, that's an opportunity. If you are not able to download it, how do you protect it? So, people can access, whoever can access to my knowledge. I don't like that either. I only like that only those people who are treating me with the problem at the moment have the access and I can give the consent for you and for those people only for a limited time and for limited usage for all purposes.

Interviewer: I see as many systems should be built for AI, as many systems should be built to prevent the negative usage of the AI. They should go both hands in hand – with all those pitfalls and bottlenecks that should be deeply protected without any possibilities for circumvention.

Interviewee: And then that is also helping us at the same time when you have the right to access my data and then you have the solution, AI solution for making a prediction, for whether I have a high risk of something or it provides a solution what pharmaceutical product would be optimal for me for this treatment, then you can utilize data for that moment, not for eternity when for all and so, AI. Now I just want to build the bridge just how I see Artificial Intelligence should be built for this kind of purposes mostly in this narrow, narrow for specific use for making the diagnosis or precision medicine and so on. This is the kind where I see that because the patient clinic for the clinical workers would be for the patient it would be good, but we need to understand all the background, all the limitations and all the opportunities that are coming from here that we have this much very kind of positive things, so we have electronic health records for decades and we have already *** and all these kind of highly-qualified clinicians whether they are nurses or doctors, whatever, so those are the good things. The challenge is so that it needs to be taken into consideration so what I want to promote is some base where I see that it is fair for all parties, it is fair for the clinician, it is fair for me as a patient, it is fair for the system so that the data can be utilized for really the right purpose and we can protect the value for the data and also the use of data for developing new solutions, we want to provide the privilege to our start-ups, Finnish start-ups, to build new solutions, and if you are multinational, you have this sandbox type of solution, ***. *** the practical solutions and we have to take into this economic impact into consideration. Then it would enable new change to tap in these opportunities, to build new AI solutions for specific use and so on and also when we know when this kind of electronic environment is supported for security things, think about. It will be very beautiful kind of setup, also new applications in this kind of systems, so you do not need to be scared about – they really have to protect the whole system, that everybody has the access to the information and so…

Interviewer: Thank you, ***, very much for summarizing our thought-provoking and compelling and in places, controversial, conversation which gave space for new thoughts which I am very thankful to you. The data protection is a huge issue, it is very essential. It needs a big picture to see, yes, it requires a lot. Thank you very much, it has been of very high value to understanding this issue and also how to judge and discuss it in the further steps. Maybe I have I last question, which might be a little bit personal, do you mind if I ask it?

Interviewee: Depending on what you are going to ask.

Interviewer: You don't have to answer if you do not want to. It is just – you already mentioned it, but the last words, your approach, your steps to take in order to avoid possible negative consequences of AI adoption, to curtail them which could happen to the industry and tap into positive ones. How do you personally approach it and how do you prepare for the upcoming changes?

Interviewee: I am working with ***, we are working with some of the clinicians ***. Of course, I have been, ***. Because many people have been betting on this openness aspect and they have tied their kind of hands, from that perspective, and they have associated also with big companies and they already linked with them and married with them, they are not able to even touch this issue. So, this is the problem we really need to take into consideration, I want to talk about that. I don't blame them, everybody plays their game with their kind of you know, assets and from their own needs. And because of that we also need kind ***, it's like in sports, doping is not allowed, doping is banned and because so it has to be certain kind of rules and regulations for this. When big boys

and girls are utilizing the unfair competitive advantages against the start-ups, that's not a fair situation, and if we consider even more the economic impact what would be more even cheaper solution and approach ***. For some reasons, basically, I did not ***.

Interviewer: Hopefully, things will change for the best.

Interviewee: At the current time, the country deserves what it deserves.

Interviewer: In order to protect the crown jewel of Finland, some actions would definitely need to be taken, so that anyone could not take that gem out of the crown somewhere else.

Interviewee: Oh, that's what I really really hope, because if we make that kind of solution, if we start promoting small and medium-sized companies, not just talk, talk-to-talk, walk-to-walk, there is an old saying in this, so we have to start walk-to-walk, but really build the solution that we promoting these projects to tap into these opportunities and build then this kind of sandbox type for big companies to enable them also to operate, but not like so that they use the full power of massive advantages, and that's what I want to, I do not want to discredit anybody and I don't wanna anybody out, I want really kind of you know, have full support by everybody, but having this kind of, this kind of elements that actually, by supporting the big boys only, it leads to the situation that all of the great discoveries might end up to die and never get into the marketplace because of ***.

Interviewer: Thank you very much, ***. I think it is all from me. If there is anything you would like to say after or would like to hear.

Interviewee: We can talk about other aspects if you want to.

Interviewer: I definitely would require thinking everything over. For now, I will end the microphone recording.