Big-Data Technology in Finnish Healthcare: Barriers and Possible Ways Out

Metropolia University of Applied Sciences
Master's Degree Programme
Health Business Management
Thesis
29 March 2019

Abstract

Author	Taiwo, Adewale David
Title	Big- Data Technology in Finnish Healthcare: Barriers and Possible Ways Out
Number of Pages	55 pages + 6 pages Appendices
Date	29 March 2019
Degree	Master of Business Administration
Degree Programme	Health Business Management
Specialization	Business Administration
Instructors	James Collins, PhD (Senior Lecturer) Marianne Pitkäjärvi, PhD (Senior Lecturer)

Purpose:
The purpose of this study was to identify the barriers of big-data technology and innovations in healthcare, and the possible solutions to locally combat them

Aim:
The objective of this study is to investigate the barriers of big-data technology in Finnish healthcare as identified by stakeholders and also produce recommendations to address the identified factors.

Method:
Qualitative method was used to collect the data. Data were collected by using semi-structured interviews with open-ended questions together with the use of probing and closing questions. Also included is the unstructured participant observation diaries, and insightful emails. Deductive approach of content analysis method was used in analyzing the collected data. The participants were selected to have a good representation of all the stakeholders of Finnish healthcare. Twenty-three interviewee participated, the majority of whom are high position personnel and professionals.

Results:
The results of this study showed that many stakeholders in the industry believed that big-data analytics could be the solution to most of the current challenges of healthcare. However, the majority declined to compare the success rate of big-data in healthcare to other services, arguing that healthcare is unique and cannot be compared to other industries. As expected, the problem of data security and strictness of governments regulations on data was the most mentioned by all the participants (95% and 100% respectively). This supported some of the widely claimed barriers. However, the trust issue was not seen as a barrier, it is statistically significant ($p < 0.05$)

Conclusions:
This study established that the highly restrictive government regulatory policies of data privacy and security are one major challenge that is limiting the full potential of big-data analytics in Finland's healthcare industry. The result also suggests for an automatic systemic anonymization of data that would make health data to be less attractive to cyber-attacks and become more accessible to the data scientists.

Keywords:	Big-data, big-data analytics, data anonymization, data security and privacy, cyber-attack, regulatory policies

Contents

List of Figures

Acronyms

3V's	Volume, Velocity and Variety
A	Agree
AI	Artificial Intelligence
CDR	Call Details Records
CEO	Chief Executive Officer
CPOE	Computerized Physician Order Entry
CSA	Current State Analysis
D	Disagree
EK	Existing Knowledge
EPRs	Electronic Patient Records
ERP	Enterprise Resource Planning
FI	Financial Institution
Fimea	The Finnish medicines Agency
GP	Government Paying
GR	Government Regulatory
HI	Health Insurance
HT	Health Technology
HW	Health Worker
ICT	Information Communication Technology
IEEE	Institute of Electrical and Electronics Engineers IEEE
mHealth	Mobile Health,
MIT	Modern Information technology
MR	Medical/Health Research
NHI	National Health Insurance
NT	Undecided
OECD	Organisation for Economic Co-operation and Development
OSF	Official Statistics of Finland
PC	Pharmaceutical Company
PM	Personalized Medicine,
SA	Strongly Agree
SD	Strongly Disagree

SMEs	Small Entrepreneurs
STUK	Radiation and Nuclear Safety Authority, Finland
THL	National institute for Health and Welfare
TTL	Finnish Institute of Occupational Health
Valvira	National Supervisory Authority for Welfare and Health

Acknowledgements

The first appreciation goes to God almighty for his mercy, grace and blessings.

I would like to acknowledge and specially appreciate the roles of my thesis supervisors, for their unique support and professional assistance. I sincerely appreciate **James Collins** for his efforts in helping me to clarify my thoughts and streamline the issues address in this thesis. Much appreciation to **Marianne Pitkäjärvi**, for the core supervisory roles in the execution and writing of the manuscripts.

To my darling wife, **Abiola Rukayat**. I really appreciate your support and kindness throughout the period of writing this thesis, particularly in making up for my absence in the life of our beautiful daughter, **Olaoluwasubomi Yeyemide Bella**. Thank you so much, dear.

To all those who have been a part of my getting here, my dad (**Abayomi Samuel**), brother (**Anuoluwapo Shadrack**) and many good friends. I really appreciate you all.

Finally, to my late mum, **Abisoye Asabi**, you're the reason I kept on pushing forward. Rest on maa'mi. I love so dearly MUM.

1.0 Introduction

This study seeks to identify the barriers of big-data technology and innovations in Finnish healthcare and the possible solutions to locally combat them.

1.1. Overview

Healthcare industry is a very important sector of every economy. This is not only because it is a lifesaving service industry or a very expensive industry, which consumes a larger portion of every economy budget; but also because of the complexity and delicacies that cuts across her operational process and management (Klynveld Peat Marwick Goerdeler, KPMG, 2015). Unlike other service industries where professionals are highly homogeneous, healthcare is a very complex industry. The complexity of the industry can be attributed to the confluence of different professionals, which includes the physicians, nurses, pharmacist, scientist, researchers, administrators and currently, the information technologist (Karen, 2015). Healthcare is also described to be complex because of highly diverse and large number of her shareholders. These include, of course, the patients, the healthcare providers, the insurers, the caregivers and the employers, as well as the institutions and government regulatory bodies (Walshe and Smith, 2011).

Compared to other service industries, healthcare industry has been adjudged to be highly lagging behind in the implementation and the use of big-data technology (Gillette, 2004; What, 2017), this is quite opposite in nature to the expectation, when it is well understood that healthcare is an industry of data (Archenaa and Anita 2015; Raghupathi and Raghupathi, 2014; Sarwar et al., 2017). Several excusable and inexcusable reasons have been adjudged to be responsible for this slow and unsteady adoption, however, no matter the numbers of reasons adjudged for this inept tradition, the need for rapid and entire overhaul of healthcare operational system with the use of modern technology is imperatively high and obvious. There are two reasons why the overhauling is inevitable. Apart from the rising cost of healthcare, the payers (Patients, Health insurance and Governments) are now and increasingly basing reimbursements in the quality of care provided, not just on the numbers and type of procedures but the satisfactions of care receivers (Thomas and Laura, 2016). The second reason is because the price of modern technology is continuously plummeting, becoming extremely cheap as they become more refined and advanced when compared to the economic value they provide (Digital Enterprise 2016; Karen, 2015).

As briefly mentioned above, Healthcare industry is traditionally an industry of data, which is known for continuous generation of data from all its various activities (Archenaa and Anita 2015; Langkafel, 2015; Raghupathi and Raghupathi, 2014; Sarwar et al., 2017). These data, which have always been generated for the purpose of record keeping, compliance and regulatory requirements, managements and patient care services purposes (Sarwar et al., 2017, Raghupathi, 2016; Raghupathi and Raghupathi, 2014) can now be managed to become the most valuable property of the industry. These data are characteristically voluminous, inhomogeneous, and highly disorganized and diverse (Raghupathi and Raghupathi, 2014), this is because healthcare industry itself is a very complex industry. Complex in service, operation and organisation. The data usually includes clinical data from medical and clinical researches, clinical decision support systems which includes, for example medical imaging, laboratory test results, physician's prescriptions notes, insurance decision and many other health administrative related documents. Also included is the patient data in electronic patient records (EPR); computerized physician order entry (CPOE) and all machine/sensor generated medical data. (Frost, 2012; Raghupathi and Raghupathi, 2014). Social media posts and web pages; emergency care data, news feeds, and articles in medical journals are much more part of healthcare big data (Raghupathi and Raghupathi, 2014); These data sets are increasingly becoming so large and complex, marjorly because of technological advancement in the many aspect of healthcare delivery, thereby making data storage and managements becoming more difficult and highly impossible with the traditional hardware and software (Frost, 2012; Raghupathi and Raghupathi, 2014).

Healthcare data is evidently a 'big-data', this is not only because of its size, but also because of the velocity at which is being generated, its variety, and un-structured-ness; however, with the emergence of digitization of large amount of data and data analytics, the data are becoming incredibly important and cardinal to the solution of various challenges identified with Healthcare industry (Priyanka and Nagarathna, 2014). Big-data analytics has greatly reshaped other servicing industries like banking & Insurance, hospitality, manufacturing, and education (Minelli et al., 2012; Mona, 2017). Adoption of big-data analytics in most of these industries has given birth to different business models which has leads, not only to the improvement of services and process efficiencies, but most importantly to the high degree improvement in customer satisfaction innovation among other things. (Gordon et. al., 2013; Karen, 2015; Minelli et al, 2012)

Just like other industries, adoption of big-data analytics in healthcare is expected in healthcare. Majority of the healthcare stakeholders have identified and also agreed that big-data analytics could to be one of the major catalysts to the process of providing solutions to both the economical and value-delivering problem of healthcare industry (Brian, 2013; What, 2017). The result from its application is expected to help senior decision makers to make best possible decisions to help in delivering better and quality care, and achieve greater efficiencies in the industry (KPMG, 2015), however there have been barriers to efficient adoption and implementation of big-data analytics in the industry. Recently, healthcare has experienced tremendous change due to the emergence of digitization of data. This phenomenon has totally changed how healthcare data is being collected, stored, processed and analyzed, hence the advance use of the collected data beyond the traditional regulatory and record keeping purposes is trajectorially progressing. In contrast to the expectation, the recent advance in data digitization of healthcare has failed to reciprocate a correlated level of big-data analytics and technological innovation in healthcare as expected. The factors for this lagging have been the hot topic of research and debate in health tech and health management of recent, despite many factors identified, there is no clear headway yet. (Feldman et al., 2012; KPMG, 2015).

With this study, we joined the league of researchers in studying the factors responsible for the slow or delayed output of big-data analytics in healthcare. Though most healthcare issues are globally-related; this study is however scoped strictly to identifying the local (Finnish healthcare) factors associated with big-data analytics in the Finnish healthcare industry and the possible ways to ameliorate the situation.

1.2 Present Challenge

Finnish healthcare is indeed one of the best in the world, as it has earned its marginal leads for years due to her high level of commitment to technological advancement in scientific and medical research. (Finland Health (a), 2016; Peter, 2017). In Finland, the technological research is well accompanied with continuous update and implementation of policies, supported with strict regulatory standards that monitor the conformity and compliance at every level. Finland is known for its cutting-edge technology and her health technology holds largest share of its high-tech

export, thereby making Finland to be one of the three strongest health technology economies in the world. (Finland Health (a), 2016; Peter, 2017).

Being a hub to digital health technology, one would expect Finland to be leading in the implementation of big-data technology in healthcare, after so many years of hype and jamboree media about the prospects of big-data technology. However, despite much advancement in the technological aspect of big-data analytics, Finnish healthcare has been adjudged to be far much behind in big-data analytics, just like other economies, when compared to other Finnish industries like Transportation, Banking, Insurance, retail stores and games.

Finnish Game and Banking industries are among the list of industries that have greatly benefited from full potential and capacity of big-data analytics. However, like every other economy, Finland healthcare is facing barriers that are impeding and scaring away the actualization of full potential of big-data analytics benefits against how is being enjoyed in other sectors of Finland economy. Some of these barriers, for one reason or the other, could not be clearly identified. They could also appear intangibly concrete due to how most of them sound vague or complex. The good news, however, is how the key stakeholders in the industry have unarguably agreed that innovation and implementation of data-technology in the industry are lagging to the expected level. This study therefore aims in identification of the barriers and the possible solutions by engaging various stakeholders of the industry in Finland.

1.3 Objectives and Scope

The objective of this study is to investigate the barriers against the efficient implementation of big-data analytics and technology in Finnish health industry as identified by various stakeholders. The study will also propose recommendations to ameliorate the combating factors.

To achieve the study objective, we engaged qualitative approach in addressing following issues:

- The current barriers of big-data technology in Finnish healthcare as identified by various stakeholders.
- The possible solutions to alleviate the identified problems

The outcome of the findings is a report with a set of recommendations for the consigned shareholders, majorly the healthcare managers and government agency on how to remotely address the current trend in order to match the results with hype of big-data technology in healthcare industry.

2.0 Method and Material

This section describes the method and materials used in this study. It also discusses, in details, the categories of data collected, the data collection process and how it is qualitatively analysed

2.1 Research Approach

This study is an applied research which seeks to identify the possible barriers of big-data analytics in Finnish healthcare industry and provide possible solutions to the identified problems. To do this, a qualitative method was considered most appropriate.

An applied research entails production of an outcome (Product) from the research findings that is relevant to a specific context of a system and can be applied to the system to improve the process or introduce a new process enitrely (Balakumar et al., 2013). Apart from the aim of applied research, its procedure of research is highly suitable for our study objectives. Applied research proceduces involves identifying a problem, scoping it towards a specific context and research objective; then understanding what has been said before (the literature), then collecting and analysing data, then findings reporting, and finally, drawing conclusions that would be used to produce an outcome that would applied to the system to improve the process or introduce a new process to make a better result (Balakumar et al., 2013).

Qualitative method has been adjuged to best method when the theory of a research is still in the early stage when the study models and the theories of the research are not yet developed; particularly, when the research field is new and tends to changes at a constant and rapid pace that usually characterise early stage in any research (Benbasat et al., 1987). These aforementioned characteristics suits and perfectly describe the studies that are cordinated on big-data technologies

in healthcare – they are studies that are still at very early stage and the field is also, constantly emerging and evolving due to continuous emergence of new technologies, particularly digitalization (Feldman et al., 2012; Frost, 2012), and other hidden factors that are not obvious to the researchers. Apart from these, the in-depth nature of qualitataive method, as described by Patton (1990) - a qualitative research as a form of naturalistic inquiry method which involves 'studying the real-world situations as they unfold naturally in a non-manipulative, non-controlling and non-obtrusive ways; that are open to welcome whatever results that might come with a lack of predetermined challenges on the outcomes of the study.' This is a kind of method that will enabled us to probe our why- and how- questions concerning the problems of big-data technology in Finnish healthcare.

Another consideration for selecting this research method as appropriate for the study, was based on the fact that it seems most appropriate to assume that not very many studies has been done on ascertaining a barrier of big-data technologies in Finnish healthcare. Finland is a strong hub for Modern Information technology (MIT), we therefore have enough companies on our list to interacts with but getting them to open up on challenges may not be something a little difficult. One of the strategies of qualitative research is a field study. Field study can be through a participation, observation, in-depth interviews and documents review. Interview has been one of the oldest method of data collection and of course, an effective method. Interview is an action-based practical means through which information are gathered directly from the source, this is mostly important when the about researcher cannot directly and accurately observe situations to arrive at the conclusions. Example, in a situation like people's thoughts on a topic or situation. (Merriam, 2014). This is because, it provides a more efficient and timely way of data collection when compared with direct observing or any other known method of data gathering. For example, if an expert is interviewed, it can provide a detailed and succinct summary of wide range of information, expertise and professional knowledge gained over a period of time during a discussion over a cup of tea more perfectly than studying or observing the field in discussion. Merriam (2014) ascertained that interview is still the best technique that can be used to study cases that involved small numbers of selected objects. Therefore, the data collection method used in this study.

Based on the technically of the subject matter's content and expertise level of the correspondents, the interview was composed to be mostly open-ended, but with little predefined limitations; this is

for the purpose of making the interpretation easier and to also ensure that all the area of interests is covered by the interviewee. This was necessary in order to let interviewee express their views freely and contributes without any limitations from the interviewer.

2.2 Research Design

The reasearch and the thesis write up was designed to match the study of the identification. As stated in the thesis objectives, the problem of big-data technology in healthcare would be identified through the healthcare stakeholders. The same stakeholders would be investigated for solutions which will form basis for the solutions that would be proposed by this study.

As depicted in FIGURE 1.0, the step that gave birth to this study, are usually vocal and clearly mentioned in the public academic circles and even in the media; the lackdesstikal or slowness in the embracement of big-data technology in healthcare as compared to other industries or to the expectation. The objectives of the research is therefore to identify the causes of the challeges in Finnish healthcare context, and also profer possible solution, which will of course, mostly rooted from the solutions from the interviewed stakeholders combined with information from literatures.The current state analysis was conducted qualitatively. Data were collected by sending questionaires to healthcare stakeholders. Academic journals and reviews, internet page of some companys involved in health data managements, and blogs were also used as source of data that formed the knowledge base about the current state of the situation. The data collected were used to used to form the basis for some of the research arguments, and the analysis of the data collected, together with the prexisting knowledge to make initial proposal of the study.

Healthcare is an international profession, and most challenges, especially the economical ones are usually global and same across the borders (Walshe and Smith, 2011), therefore, the existing knowledge about the issue surrouding the identified problem were sought after from literatures, journals and reveiws, and social media sources, especially the blogs.

The innitial proposal of the study, was formed on the basis of result of analysis of various data obtained from the current state analysis (CSA) and informations from the studies on the pre-existing knowledges.

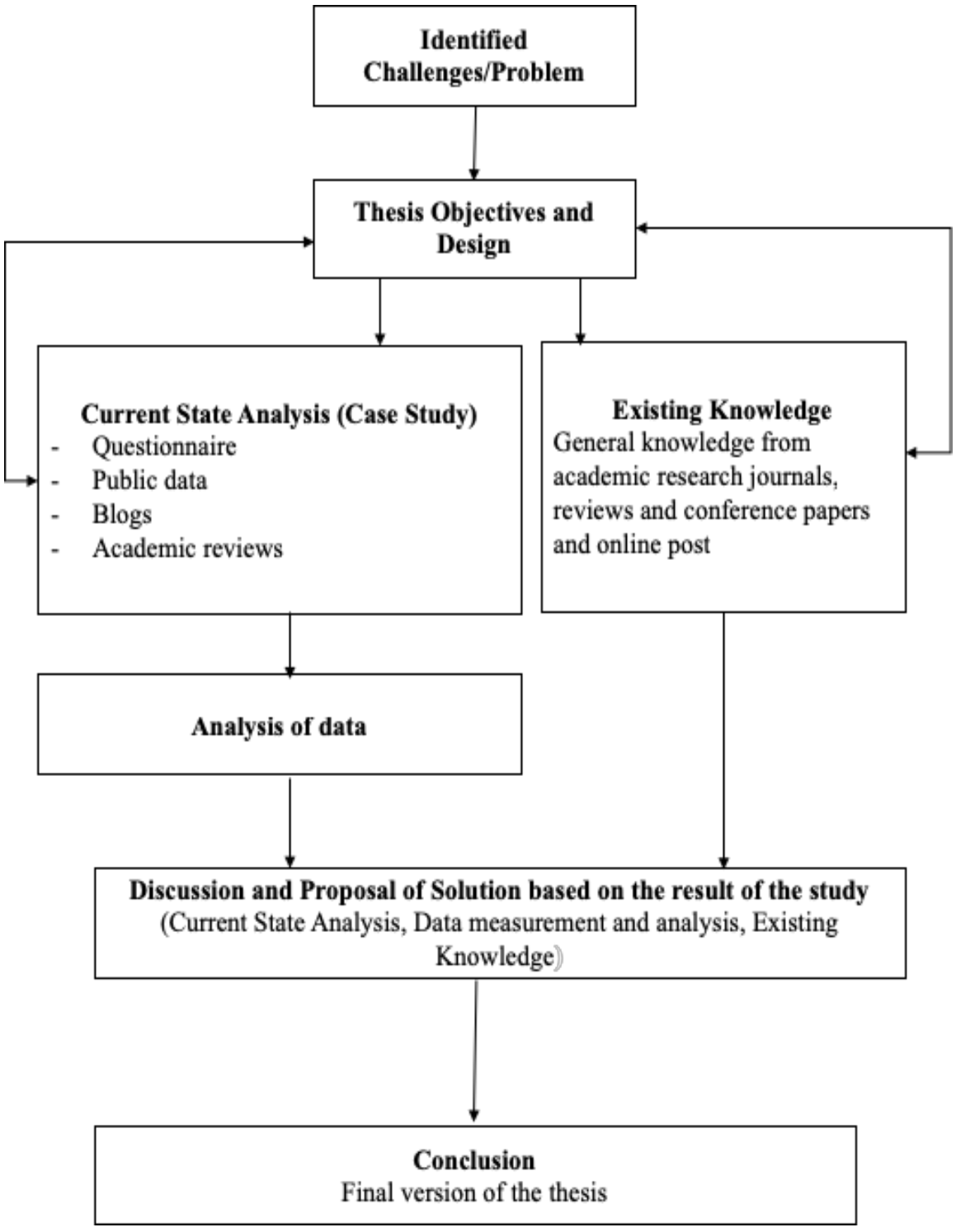

Figure 1. The Schematic Overview of the Study Design
Schematic representation showing the overview of the study work.

2.3 Data Collection

The data collected in this study were categorised into two. The first category (**Category 1**) comprised of qualitative data obtained from field research. These data were collected via interview form sent to the interviewee through email. The interview form was designed using a template by European commission on Communication on Data-driven economy question (European Commission, 2015) and Knowledgent Report (Knowledgent, 2015). The second category of data collection (**Category 2**) is a secondary data, these are sets of qualitative data obtained from literatures and publications.

Using the snow-ball approach, primary data was collected from interviewees while academic journals and articles, and other online resources with the contents that are related to the use of big-data analytics and technology in Finnish healthcare are used as secondary data source. The list of interviewees was generated to be a good representation of different stakeholders of health care in Finland. The participants are good representatives of Finnish healthcare stakeholders and their selection are based on their level of expertise and years of experience. Forty-two people were contacted with the request for a remote interview via e-mail. The email was sent containing the clipboard link to the interview page. A number of correspondents replied to excuse themselves from participating, while we got some automatic replies from some email addresses that the users are on annual leave. At the end, a total of twenty-three (23) correspondents responded between October 16 and November 12th, 2018. The selection of interviewees was done strategically to have a rich representation of all the Finnish healthcare shareholders.

2.4 Data Analysis

The collected data analysis was done using content analysis method as proposed by Tuomi and Sarajärvi (2009). Content analysis of qualitative data can be done via two approaches. These include the inductive and the deductive analytical approach. Inductive content analysis approach are mostly used for studies with no previous or background knowledge or theory which can guide the researcher through the analytical process. The study is therefore done from single observation to a more wider and bigger scope to gather data that would be analyse to to induce research questions. In contrary, deductive content analytical approach are used for a study that have an

established theory and laced with previous knowledge. The already existing knowledge and theory would serve as parameter guide in the data analysis using content analysis method. (Tuomi & Sarajärvi 2009).

Considering the topic and pool of studies already available on this subject, we used deductive approach of content analysis method. This approach is fits more and efficiently suitable because of a limited number of the respondents, therefore the deductive approach was deemed more suitable (Tuomi & Sarajärvi 2009). Using the literature as guide, an analysis frame was conducted for this study

3 Existing Knowledge

3.1 Finnish Health care system

Healthcare industry forms the major components of every economy, and in most developed countries, it encompasses between 8 and 15 percent of the economy (Walshe and Smith, 2011), and obviously bigger than education, agriculture, IT, tourism and telecommunications; making it one of the largest industries of any developed economy (Walshe and Smith, 2011). Apart from being an industry that organized professional service, for the crucial purpose of the maintenance of health affairs of lives of a country by the treatment and prevention of diseases, injury, illness and other physical and mental impartments (Griffin et al., 2016); Healthcare is the biggest employer across the world (Shelby, 2017). In Finland, according to official statistics of Finland (OSF) by the Labour force survey of 2017 released in June 2018, Healthcare is the largest employer with 16.32%, followed by Manufacturing (14.34%), Professional Scientific, Technical and Administrative services (11.44%) and wholesale/Retail trade (11.40%) (Statistics Finland, 2018). This clearly, together with the fact that large chuck of every economy annual budgets goes into health and health related industry, tells how important it is to consciously study the trend of change in health industry.

While the nature of service of an industry dictates its distinctive characteristics, however it is well known that industries or organisations are the products of the environment and context they exist, and that is why, despite the common goal and aim of every national health industry, they are distinctively different (Walshe and Smith, 2011). Health industry across national boundaries are shaped by the pollical views, religious beliefs, economic strengths, demographics and culture (Walshe and Smith, 2011). Therefore, it varies significantly by country, this includes how it is financed, who is financially responsible, who is covered, what services are delivered.

3.1.1 The Overview

Healthcare system in Finland is government majorly funded, offering a high standard and universally covered comprehensive range of health services. There 311 municipalities in Finland, which are directly responsible for the provision and funding of majority of the health care services needs of their residents (Finland Health, 2016; Local Finland, 2017). The specialised care is provided by regional hospitals. There are 18 regions, each of which comprises of different municipalities. Regional hospitals are owned and funded by the members of the municipalities. In Finland, each region has one or more hospitals, out of which one would be a central hospital. While municipalities and regions organize health services across the nation, the national government through the Ministry of Social Affairs and Health provides general health policies. The ministry monitors and direct health care system at the national level, with responsibilities, through different agencies, of policy and goals development, legislation, control and reform enactment (Finland Health, 2016; Ministry, 2013; Taperi et al., 2009)

Apart from public municipal/regional health care delivery system in Finland, there is also the statutory National Health Insurance (NHI) scheme, Occupational health care system and the private (voluntary) insurance scheme (Ministry, 2013; Melkas, 2013). The NHI offers a highly explicit coverage of health services than municipal health system, this includes the reimbursement of cost of outpatient drugs, the cost of transportation to health centers, supports for cost of care from private providers, the provision maternity leave allowances and of sickness leave allowance, and the provision mental health rehabilitation support and services (Taperi et al., 2009). It is compulsory, under Occupational Health care Act of 1979, for employers to provide and cover all occupational health care services for all their employees. This entails provision of health services required for all work-related health issues and conditions. Lastly the private insurance system, this is system of health funding or delivery is quite new and not very common in Finland because it is voluntary with very limited scope, for example, it is not available to the elderly.

Finnish healthcare is system is today one of the best among the OECD countries and even the world at large, this holds to several national health policies which focuses on prevention of diseases and promotion of health standard for all the citizens regardless the social status (Finland Health, 2016). The constitution for Finland guarantee, for every citizen, an adequate, social, health and

medical services. The achievement which is a product of a series of consecutive initiates and reforms, responsively targeted towards the changes in every indicator required for the achievement of a world class health system (Taperi et al., 2009).

3.1.2 The Structure of Finnish Health Care System

Structurally, health delivery in Finland is done through two-parallel systems. The two-service delivery system are not mutually exclusive, but are rather complement to each other, but at times, overlap- each other. The two systems are categorically municipal health care system and private health care system (Ministry, 2013; Taperi et al., 2009). Occupational health care system can be categorized as the third system, this is because its funding provision is governed by a separate legislation, despite the fact that this category of cares is normally being delivered by either municipal or private care providers (Taperi et al., 2009). Yet it cannot be classified as a third delivery system because the care is usually being delivered by either municipal or private care providers.

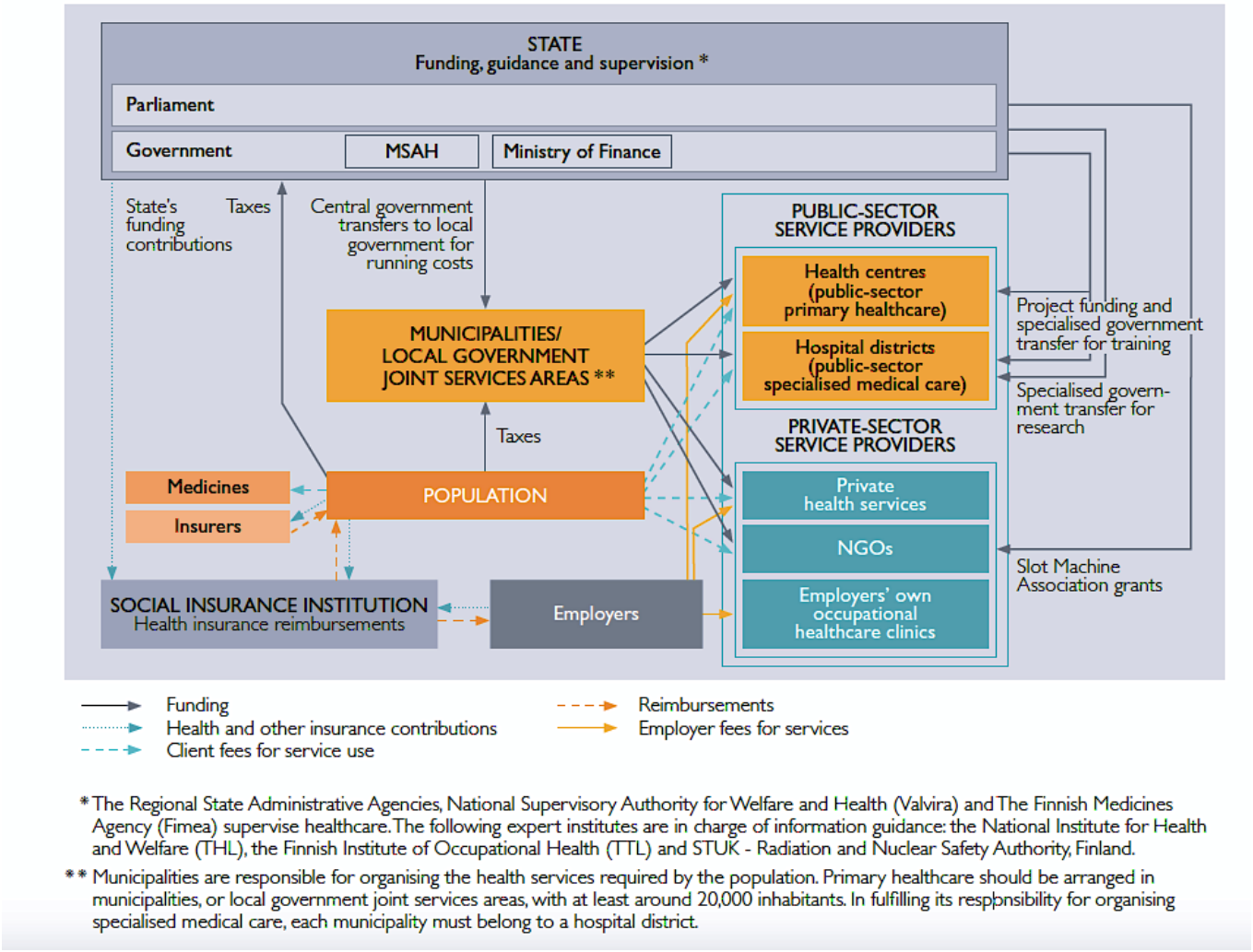

Figure 2 The organisation, funding, provision and supervision of health care services in Finland. The figure depicts the funding of public the health system as well as how the regulatory roles are structured across every level of government. Municipalities are in centrally placed, charged with the responsibilities of providing health care services to her citizens, while the federal government body is charged, majorly, with regulatory and supervisory roles.

Ministry of Social Affairs and Health, 2013. Health care in Finland (Pg.10)

3.1.2.1 Municipal Health Care System

The three levels of health cares (i.e. primary, specialised and long-term cares) are provided by municipal health care, but in a different scope. For every individuals, the public health care and specialised medical care needs, as well as social welfare needs are catered for for by municipals as defined by law (Taperi et al., 2009). However, municipal authorities decide on the modalities of providing these services for her own members; that is why the way these services are been provided vary across the municipalities.

The healthcare is funded by revenue of municipal tax especially the primary health care, while the specialised care, in most cases are usually done by the support of the central government. The amount paid by the central government to supports to municipalities depends on certain factors like the population and the population structure, the morbidity, among many other factors (Ministry, 2013).

The health care provided at municipal level includes prevention healthcare services, medical care and the rehabilitation care, centralized health services, mental health and substance abuse care, and finally occupational health services. However, these services are broadly categorized into three main categories of cares as (i) Primary healthcare (ii) Specialised healthcare and (iii) Long term healthcare. Depending on the category of the care, which can be provided by local municipal or by joint municipal (regional) healthcare units. (Taperi et al., 2009).

3.1.2.2 Private health care system

The private healthcare system provides services that are in parallel with but majorly complement the public health care services. The private providers in Finland include the enterprises, non-governmental organisations, and private health enterprises who can sell their services directly to individuals as well as to the local and joint municipal authorities.

Private care majorly provides primary and occupational health care. Finland's health care services of the 21st century have begun to see an influx of private providers, especially with the recent reform of the sector, and now just over one-fourth of social welfare and healthcare services are provided by healthcare enterprises and non-governmental organisations either as outsourced services by the government or directly to the clients (Taperi et al., 2009). However, the services provided by private enterprises are still very limited and restricted, the most common private services are dental care, physiotherapy, doctor's surgery and largely occupational health care (Ministry, 2013) while the large percentage of private healthcare service providers operates mostly in the larger cities across the country and also the southern part.

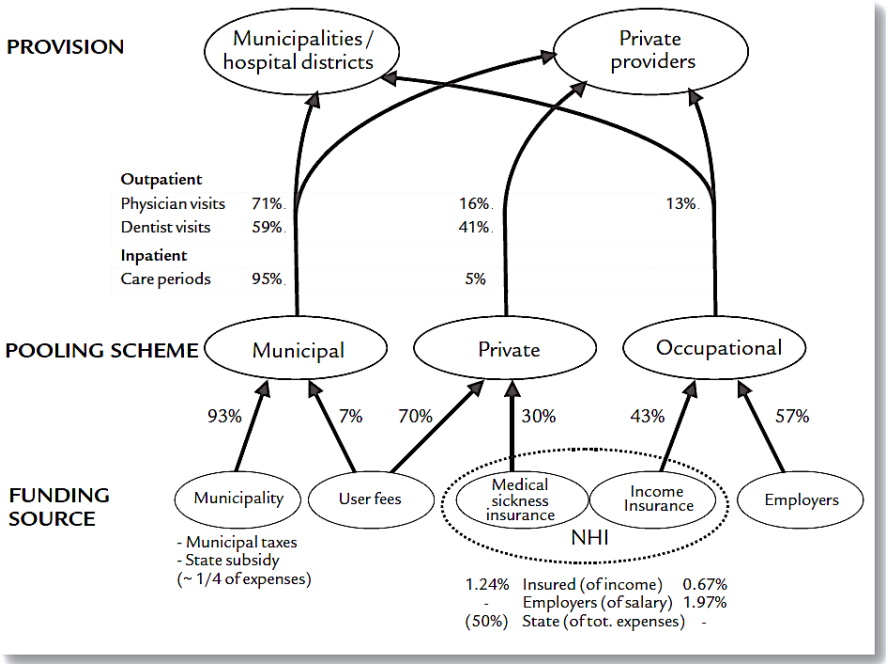

Figure 3: The parallel funding of Finnish health care. Municipal and Private are the two, but parallel, main source of funding while occupational is also known to be the third source. However occupational healthcare is funded through the government purse but enacted by entirely different Act.

(Teperi, J., Porter, M.E., Vuorenkoski, L. and Baron, J.F., 2009. The Finnish health care system: a value-based perspective. Sitra reports, 82. (Pg.4))

3.1.2.3 Occupational health care system

Occupational health care system is the third system of accessing healthcare in Finland. The Occupational Health Act of 1979 clearly stipulates and obliges every employer to make provision for occupational health care services for all their employees, the act strongly stipulates and makes it compulsory for all employers to provide health care services to cater for all work-related risks. The care services include the first aid services and the physical examinations for employees at the workplace, with compulsory periodical health status check for all employees whose work are categorized hazardous.

Employers can provide the services internally, if she has the capacity, or outsource them to municipal health center or a private service provider (Ministry, 2013, Taperi et al., 2009). However, and most commonly, most employers in Finland provide their occupational health

services through municipal health care system, but some also do outsource to the private healthcare companies.

Notably, despite the fact that there is a distinctively different legislative framework and separate funding mechanism for occupation health care, it is officially within the scope of primary health care, and that is why the employers can claim reimbursement for the cost of procured in providing occupational health care for their employees.

3.1.3 Shareholders of Finnish Health System

Healthcare varies significantly by country across the world, and as earlier mentioned, the structure and political policies are among the factors that characterized these differences (Walshe and Smith, 2011). One of such important factors is the stakeholders, the bodies that constitute the stakeholders, and the relationships with policies that govern their activities plays a pivotal role that defines the mode operandi and efficiency of every system.

Healthcare shareholders are people or group of peoples that are involved in the healthcare's provision, finance, regulation, policy making etc. There are seven categories of them, with each category comprising of different players (Griffin et al., 2016; Walshe and Smith, 2011). In Finland, these shareholders are grouped into the following categories:

1. Consumers: Consumers are the primary stakeholders this is because their awareness, purchase and use of healthcare dictates most often the existence of company. The healthcare consumers are same as other service industry consumers; 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), therefore consumers are regarded as latest boss of healthcare industry. In a wider sense, consumers are not limited to the patients and their relations but also caregivers, patient advocacy organizations (Griffin et al., 2016).

2. Clinicians: These includes the clinicians and other related professional. These are at the group of people at the center of medical decisions making. They are mostly involved in the generation

and analysis of medical data determines the outcomes and the quality of cares received by the patients. They therefore, required a well-grounded and roboust source of reliable data to make good diagnostic or treatment choices.

3. Healthcare Institutions: Healthcare Institutions includes health and medical institutions such as hospital systems and medical centres, and their associations. These are mostly, in many countries set up by the governments, and many decisions taking by these institutions are made on broad and global view of health and economic challenges. They are pivotal to successful operation of healthcare system of any country and most of the decision at this institutional level determines the health outcomes of any society.

4. Purchasers and Payers: These are the payers for cost of healthcare service procured. They can be public, private and even the employers through or not through insurance policies. This category of stakeholders plays important roles in choice and decisions of individuals about the treatments and diagnostic choices. They make decision on where, how much to pay and what type of care to take based on many factors.

5. Healthcare companies/Manufactures: The manufacturers of treatments and devices are another main stakeholder which relies on many factors to make decision on what service to provide and what research and development to be carried out.

6. Policy Makers: Healthcare policymakers are majorly government regulatory institutions which are usually at different levels of governments such as at the federal, state, and local levels. The policymakers at all levels, make healthcare policies based on the best available result and situation to get best and sustainable health-based result. They acts to control every activities of all stakeholders in the sector to provide quality care and patient-centered and satisfactory services without compromising the basic rights of the patients

7. Healthcare/Medical Research Institutions and Researchers

3.2 Big-Data Technology

Big-Data, a buzzword that has found its way since 1997 into event titles of most panel discussions, conferences, articles, business discussions across every industry and business empires at a phenomenal rate (Langkafel, 2015). It has also been a hot topic in the academic environment. Though the momentum and popularity of the term is recent among the general public, but the term 'big-data' was first used in the year 1997 by the NASA researchers (Michael Cox and David Ellsworth) to explain the visualization of data and the challenges it posed for computer systems during during a paper presentation in an Institute of Electrical and Electronics Engineers (IEEE) conference (Cox and Ellsworth, 1997; Wang et al., 2015). Since then, big-data has entered several revolutionary stages, and with the same level development in digitization, clouding computing, and internet; big-data has become a pooled source of information, knowledge and extraction (Sarwar et al., 2017), which formed this basis and intelligence for most of the new business opportunities and business models in all industries. Big-data applications are endless, and its importance is already indispensable in sectors like traffic control, weather forecasting, Security, fraud detection, service and product innovation, healthcare and education

Big-data has been defined in several ways, definitions can sometimes describe the features and characteristics while definitions describe its technicality and applications. The most common version of the definition is "data sets that are so big and complex that traditional data-processing application software are inadequate to deal with them" which also agree with that of O'Reilly Radar (Feldman et al., 2012) while Gartner IT-glossary defined it technically as "a high-volume, high-velocity and/or high variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation." (Gartner, 2018). So, on general acceptance level, big-data can be referred to as a data sets, with data size that is beyond the ability of conventional software tools to capture, analyze, manage or store. We are in the generation of data generation, and in recent times, the frequency data generation has been exponentially exploding, for example, more 90% of the world's data were generated just in the last two years (Feldman et al., 2012). Apart from the explosion of data experienced in social media (FIGURE 4), almost every business and activities are now digitized, allowing service providers to capture trillion bytes of information about their customers, partners, operations etc. As depicted in figure 4, Large percentage of healthcare customers are internet and social media users who are generating data with almost every aspect their life

Figure 4 Popularity growth of information technology

(Chaffey Dave 2018, Global Social Media Summary 2018. Smart Insight)

There are some key characteristics have been the major component of any dataset before being considered big-data, these are called big-data Vs. Historically, first between 2001 and 2008, big-data was characterized with 3Vs (Velocity, Volume, and Variety), then based on the application usefulness, it became 4Vs (Velocity, Volume, Variety and Veracity) (Archenaa and Anita 2015; Feldman et al., 2012) and finally now, 5Vs (Velocity, Volume, Variety, Veracity and Value) (Marr, 2015). Velocity refers to the fast rate at which large amounts of data being generated, Volume refers to the quantity of data that is being generated. Variety and Veracity refer to the different kinds of data generated and messiness or trustworthiness of data respectively. The final V, Value, refers to the benefits/value embedded in the data and the need to turn data into value for better business understanding and improving decision making. Big-data was however recently described with 10Vs (FIGURE 5) by Gunasekaran et.al listing them to include *Volume, Velocity, Variety, Variety, Veracity, Value, Validity, Variability, Viscosity, Virality* and *Visualization* (Gunasekaran et.al 2017)**.** The research about big-data has never been conclusive; it has always been emerging. Such is the case with the characteristics of big-data, which was earlier described with 3V's, then

4V’s before 5V’s. However, with the advancement in technology and research, big-data is now comprehensively described with 10V’s.

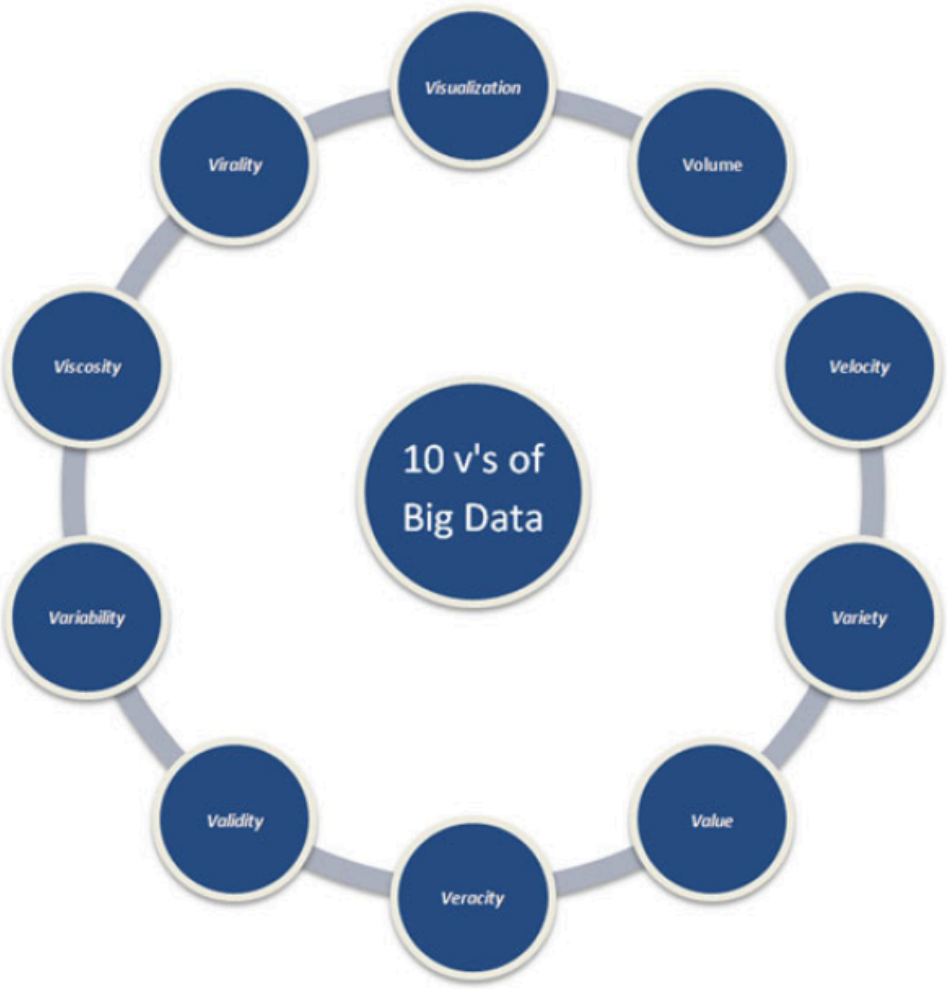

Figure 5 10V’s of Big-Data: The advancement in technology and research, big-data is now comprehensively described with 10V’s.

(Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B. and Akter, S., 2017. Big data and predictive analytics for supply chain and organizational performance. Journal of Business Research, 70, pp.308-317 (Pg.135)).

Big-data are typically generated from three sources. These are (i) Traditional enterprise source, this includes the CRM systems, transactional Enterprise Recourse Planning (ERP) data, web store transaction and general ledger documents (Archenaa and Anita 2015). (ii) The machine generated or sensor-generated data, this includes call details records (CDR), weblogs, equipment logs, trading system data, smart app meters, manufacturing sensors etc. (iii) Social media is the third source, this includes customer feedback streams, microblog and social media sites like Facebook, Twitter, Instagram, LinkedIn etc. In the 4th industrial generation, Big-data is the fuel and much important as the oil (Feldman et al., 2012). Similarly, like crude oil, big-data is crude and not useful with high tendency of causing great nuisance unless is processed. Big-data needs to be processed by analysis, important information can be extracted from big-data by using different and applicable analytical method – Big-data Analytics. Therefore, big-data analytics is the process of making value out of big-data, which involve steps of combining of multiple of unrelated and unstructured datasets, processing them and harvesting hidden information (i.e. value) in a time sensitive manner (Amirian et al., 2017a). Processing of big-data is the challenge of big-data analytic itself, and it is a process that involves four (4) different stages of Data collection, data storage, data processing, and data analysis and report (Sarwar et al., 2017), all of which are checked with security and privacy threat FIGURE 6 (Amirian et al., 2017a; Amirian et al., 2017b).

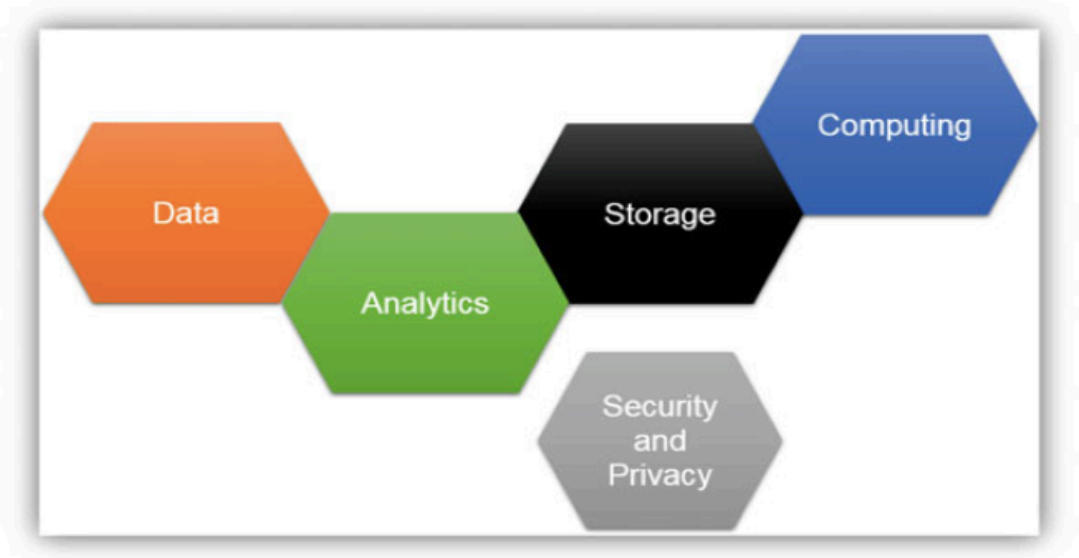

Figure 6 Five dimensions of Big-Data.
The dimensions involved in Big-data analytics processing

(Amirian, P., van Loggerenberg, F. and Lang, T., 2017. Big Data and Big Data Technologies. In Big Data in Healthcare (pp. 39-58). Springer, Cham (Pg. 41))

3.2.1 Big-data technology in healthcare Industry

Healthcare is historically an industry of data (Archenaa and Anita 2015; Sarwar et al., 2017; Priyanka and Kulennavar, 2014). However, the advancement in digitalization, computing systems and internet of thing (IoT), has greatly impacted the rate of data generation in healthcare whereby all the subsectors of healthcare, through the use of modern technology and machineries, are currently serving as source of enormous flood of electronic data as never before (Frost, 2012). Simultaneously, the industry is faced with the challenge of ever-increasing cost of care so also a constant need an improved quality service as well as constant demand for customer-oriented services (Balan and Otto, 2016; Priyanka and Kulennavar, 2014). Coincidentally, big-data, proven by track record in other service industry like banking, transportation and humanities, hold the promise of providing intelligence and insights that can adequately provide solutions to some of the challenges being faced by the industry (Feldman et al., 2012; Frost, 2012; Karen, 2015; Minelli et al, 2012). As earlier mentioned, data in healthcare comes in a huge volume and also from enormously varied sources which usually includes and not limited to clinical data but also administrative and media data (Priyanka and Kulennavar, 2014). The healthcare big-data, can, however, be categorized into six (6) big groups, which are sometimes disconnected and owned by different heathcare stakeholders (Feldman et al., 2012), these are:

1. **Care Providers**
2. **Payers and Payees**
3. **Research and Academic Institutions**:
4. **Developers and Manufactures**
5. **Patients, Consumers and Marketers**
6. **Government and Regulatory Institutions**

The data from all of aforementioned sections of health care have long been used for regulatory or management purposes, but with advancement in healthcare technology vis-à-vis digitization, an increasing number and different organisations, ranging from non-profit, to business enterprises and even big health financial organisations are beginning to see big-data

analytics/technology as a true way to address most of the healthcare challenges. Despite slowness in embracing the big-data technology (Frost, 2012), this industry is already enjoying an overwhelming turn around in services and operation through the use of big-data; these together with the other potential opportunities that lie in big-data technology can also be categorized in six categories (Feldman et al., 2012):

i. Data to Information Transformation.
ii. Research and Development Support - Genomics and Beyond
iii. Health Self-Care Support
iv. Service Providers Support – Improve quality and efficiency Patient Care
v. Patient Health Awareness
vi. Health Data Pool for global collaboration and easy access.
vii.

Healthcare data is most sensitive and most sought after, in 2016, according to Identity Theft resources center, healthcare industry alone accounted for almost 35% of reported data breaches (Secure Destruction, 2018), while in September 2017, Brevard Physician Associates announced on the company's website that its Florida based facility has been burglarized. Health data of about 7,976 patients were claimed to be under security threats due to the attack (Elizabeth, 2017). They later confirmed that, out of three computers that were missing from the burgling activities, one of them is containing not less than 5 audit files of the patients. This incidence and statistics show how valuable and precious is the healthcare data, yet the industry is making no good use of it. According to Caroline H. & Jim F. 2014, a piece of medical information costs up to ten times more than a credit card information in the black market. Medical statistics including insurance and billing information sell for up to ten dollar each, where credit card numbers may go for $5 each in the US (Caroline and Jim, 2014). This shows why the reoccurring burgling and cyber-attacks on healthcare data facilities. The big-data analytics companies have been in top gear in transforming these data into usable information, making it a well-structured data for machine management in efforts to make health care become a data-driven service industry. Now, healthcare data can be managed and employed in the development of cloud-based predictive analytic software which for example, can explain patterns, using the data from the hospital datasets, of how to reduce the hospital readmissions and prevent hospital-acquired conditions, help to aggregates population data across multiple sites to improve clinical research and public health analysis; help to address needs

in revenue cycle management, compliance, and analytics, and also in standardizing health records across different providers among others (Feldman et al., 2012). Some of the big players in this area of big-data applications include the likes of Predixion Software Inc, Health Fidelity, Practice Fusion Inc, Anthenahealth Inc among several others.

Several health apps and machinery now collect health data and help in supportive self-care for care receivers while providers in other end are now enjoying many service supporting applications or technologies adapted from big-data technologies which not only supports the caregivers but also improve the quality of care. With the use of big-data technology, cloud computing and IoT particularly the social media, consumers are now well aware of so many issues in healthcare and now appeared to have more control and be in the center position. Another interesting but not yet popularized application of big-data analytics is in the building of a better ecosystem (Feldman et al., 2012), Qualcomm Life Inc is a company that is doing this by opening a global wireless health connectivity platform to create environment for software and analytics companies and device companies where big-data of different sources would in mixing and matching in order to become more readily available and accessible. This is believe to make data to be more valuable and appreciated rather when it is available as an isolated pieces of data (Feldman et al., 2012).

In summary, big-data and big-data analytics have been recognized to provide several opportunities for health care through improvement of the quality of care, managing population health, early detection of diseases, improve decision making and cost reduction (Kruce et al., 2016, Raghupathi and Raghupathi, 2014). There is also no contention of how it has helped in making Telemedicine a reality, so also personalized medicine, patient-centric healthcare, health-threat detection, and fraud detection (Kruce et al., 2016; Raghupathi and Raghupathi, 2014).

3.2.2 Big-Data Technology in Finnish Healthcare care

Globally, Finland is unarguably one of the leading economies in modern healthcare delivery system with unmatchable strengths in medical research, health data and clinical cocreation and finally health technology, (Finland Health, 2016). Since the success of Linux and Nokia, Finland has evolved and steadily assume leadership position in Information Communication Technology (ICT). Recent years have also been years of rapid adoption of information and mobile technology

in the country, and by extension the success of health technology (Finland Health (a), 2016; Peter, 2017). Presently, Finland leads the entire world in healthcare technology (Peter, 2017), with over 300 technology companies in Finland (Flanders, 2017). Health technology is the Finland's largest tech export sector since 2016. The value of exports of health technology rose with 9.7% in the year 2016, and US has been the destination with 34% of the export (Export, 2017). Finland healthcare system has greatly benefited from big-data analytics through eHealth, mHealth and telemedicine, and also through measurement, monitoring and imaging for medical research. Finland data centres is one of the best all over the world (Invest, 2016), so also the biobanks, which is the critical mass required to bring all the envisaged potentials of big-data in healthcare. According to claim by Olli Carpén, who is a professor and Research Director at the University of Helsinki, Finnish biobanks which already have about tens of millions of samples "The Helsinki University Hospital alone, has about 4 million blood and tissue samples which are from 1.4 million patient cases. Similarly, Turku's Auria biobank has been able to build a similar store with a similar storage capacity. He also mentioned that the first samples is over 60 years and with valuable longitudinal data in our biobanks." (Finland Health (a), 2016). Finland through its universal healthcare system and universal identification number systems is able to collect comprehensive and high-quality health data in digital format. This is achievable because Finnish citizens love and appreciate their science (Finland Health (b), 2016). Finland boasts an astoundingly high consent rate, over 90% of Finns consent to donating their samples to a biobank upon request, when compared to others, for example, the estimated 5% consent rate in South America (Finland Health (b), 2016). These are supported with legislation and skilled researchers who have helped to pivot Finland among the very best health technological hub around the world.

3.2.3 Challenges of big-data technology in Healthcare Industry

Big-data analytics and big-data technology in healthcare can still be considered to be at the nascent stage but there is no doubt that it is continuously evolving into a main opportunities provider to combat the ever-pressing challenges of the healthcare industry at an unprecedented rate (Kruce et al., 2016, Raghupathi and Raghupathi, 2014). It is also without any doubt, that big-data would help in improving the quality of care, bring the consumers to the center and greatly reduced the cost of care (Feldman et al., 2012; Frost, 2012). However, there are challenges that are pertinent to big-data which must be adequately addressed.

In healthcare, one challenge that usually and mainly comes to the fore is the data privacy and data security, this is because of confidentiality tradition in healthcare. Privacy issues have been the main issue about big-data globally, this is because internet communication and transactions, social media platforms and cloud storage have recently proved not to be adequately secured and highly prone to be accessed by unintended individual, hence misuse (Feldman et al., 2012) while on the other hand, there have been inconsistent or care less about the privacy implications of behaviors or activities of social media users; but they are always concerned about protecting and controlling their personal data, especially health and medical data (Feldman et al., 2012). In addition to privacy, data security is another great threat which has not only hinders the expected progress but has leads to trust issues hence slow or hindered adoption (Raghupathi and Raghupathi, 2014). Data companies and health organisations spend lots on storage and but bulk of the expenses usually go into improving the data security against either hacking or physical burgling (Kruce et al., 2016), yet the risk of data theft, cyber-attacks on health data facilities and unintentional loss of data or exposure of data to unathorised bodies are continuously on the rise and remain the most challenging huddle (Kruce et al., 2016).

In another tone, the conflict in the ownership of healthcare data is another challenge that tends to impede the success of big-data in healthcare (Baker et al., 2014; Kruce et al., 2016; Raghupathi and Raghupathi, 2014). Though patients logically assume they own their data, but this may not always be the case as, as caregivers and payers sometimes needs unrestricted to medical or health data to make crucial decision; this situation around ownership of data has proved to be hiccup as big-data essentially requires pooling of datasets for the purpose of extracting value. This is also connected with the facts that healthcare data are usually generated simultaneously and dependently by different stakeholders (*providers, payers, researchers, developers, governments and consumers*) who claim sole ownership to their generated data, and for one reason or the other, are reluctant to willing share the data. Whereas, these datasets need to be pooled together for the analytic purpose (Kruce et al., 2016).

However, apart from these legal or managerial challenges, technically big-data are faced with technicality issues which revolve around issues like real-time analytics, data storage, data standardization, structure and inaccuracies. There is also a lack of adequate and appropriate skilled health workers who are capable of coping with the continuous change and improvements of health/medical techniques and technology due to technological advancement (Baker et al., 2014;

Chawla and Davis, 2013; Kruce et al., 2016). Due to big-data and digitization, healthcare has been greatly evolving in methods, techniques and standard of care, requiring workers with specific skills, however, there exist a population of health workers who lack these skills, hence a significant barrier to the implementation of most of the big-data technology innovation (Jee and Kim, 2013; Kruce et al., 2016)

3.3 Health care problems and Restructuring

Globally healthcare is identified with certain challenges; these challenges together with other factors, have been calling for the restructuring of the healthcare industry in other to pave way for a safe and quality care at an affordable cost for payers (Kruce et al., 2016; Raghupathi and Raghupathi, 2014). One of the major challenges of healthcare is the continuous rise in the cost of healthcare delivery across the globe, especially in the developed countries, Deloitte reported that health care spending for most world's major economies are expected to rise with about 5.1% between the year 2015 and the year 2020 (Morris and Yoritomo, 2015). Aside from this, the problem of ageing populations, high cost of operations, lack of adequate and skilled labour, inefficiency and inadequate safety, insufficient access to information, and inadequate financing are some of few of many well-recognized challenges that are contributing to the ever-increasing financial budget demand of healthcare industry (What, 2017). The high cost of healthcare is, therefore, one of the major economic challenges facing many nations, because the cost of health is consuming the increasing shares of many nations, squeezing out other vital investments and regrettably not reflecting in increases in value delivery (Rother, 2017).

All of the aforementioned challenges are however not pressing as much as the need to restructure the industry and change the business model to keep up with the new and evolving market environment. This is because the health consumer is asking to be involved and engaged in their care.

3.3.1 Digital technology as solution to Healthcare

Modern Information technology (MIT) has been the major driver of many innovations of the 21st century; the apt transition from third industrial revolution to the fourth industrial revolution (4IR) has largely been based on the implementation and application of information technology in every sectors and industry. The level of penetration and adoption hence, reliance on information and modern technology by every organisations, sector and societies are highly unprecedented; technology has become intrinsically embedded in society and even in the human body (Nicholas, 2016), thereby every human activity is relying largely on technology, therefore, proved to be solutions to most economic and social challenges. It is a generation and era of digitization and data generation; it is a generation that represents the combinations of cyber-physical systems, the Internet of Things (IoT), and the Internet of Systems (Bernard Marr, 2016). The adoption of these technological advancements in most of the industries has largely been for the purpose of improving the quality of services and process efficiencies, but most importantly with high degree consideration for customer satisfaction innovation among other things, and just like other industries, adoption of MIT in healthcare is expected, by most of the stakeholders to be the catalyst in providing solutions to both the economic and value-delivering problem of healthcare industry (What, 2017).

The rate at which the cost of MIT is plummeting, becoming extremely cheap as they become more refined and advanced compared to the economic value they provide (Digital Enterprise 2016; Karen, 2015), and this is one major reason why health technology is the solution to the pressing challenges of the industry. For example, the first human genome to be sequence cost $2.7bn in the year 2000 compared to less than $500 now. Apart from this, what has been achieved in other service industries by the adoption and integration into the MIT have shown the imperativeness and inevitability of total overhauling and paradigm shift of healthcare industry from the old traditions to a value-based customer oriented cost-efficient service industry. Adoption of MIT exclusively in the healthcare industry has been adjudged to be a best way through which a high-quality, safe, and efficient of healthcare services can promoted and sustained. This is envisaged by its application in supporting decision-making process, quality measurement and assessment process, provision of links between different area of profession and finally in closing open loop systems (Helms et.al., 2008).

Unfortunately, despite the highly-recognized opportunities and potentials that lies in the adoption of MIT, healthcare industries have been notoriously identified to be lackadaisical in the embracement of modern information technology (MIT), when compared to other industries. Also the investments in

MIT has been traditionally and marginally lower when compared to other service industries. Interestingly, even with the slow late adoption and embracement of MIT in healthcare, the results achieved so far in the aspect patient's safety, placing the patients in charge of their health and reduction in the cost of healthcare has been tremendously high (Karen, 2015). These aforementioned reasons among many others have proved that modern information technology (Feldman et al., 2012; Karen, 2015, What, 2017) holds the main solution to most long-discussed challenges of the healthcare industry

3.3.2 Restructuring healthcare to be cost effective and customer-centered service

Over the last decades, there has been a constant and rapid change in the taste and demand of customers across the markets and industries, these changes are constantly growing, championing the reason for the innovations of different business models as well as technologies to cater for the various degrees of these changes (Brittany, 2011); undoubtedly, healthcare industry is not left out of the moving train of the change, as indicated on how healthcare costumers are increasingly seeking to be more active participants of their personal health (Brent, 2014), and in response to this, like every other industry; therefore, the healthcare of 21st century is being modelled to be a customer-centered value-delivering organisations, where patients are more involved in decision making and providers are paid for health outcomes they help to provide rather than by the number and variety of services they give (Julia, 2015), a model that is value-based business, accountable to the care given, penalizes undesirable outcomes, and provide incentives to improve health at a reduced cost (Thielst, 2011); these changes have greatly affected the way healthcare business CEOs are thinking about service quality, patient safety, patient experience and satisfaction (Thielst, 2011), and it has leads to two important decisions. The first is to make health information availably ready to the clinicians and patients and two is making patients to be part of decision-making team about their health, and integration of ITC is unique preference for the job (Robert, 2014).

Apart from the change in the satisfaction and participation demand by the healthcare customers, another major reason which has been un-neglect-ably responsible for a total change and overhaul of processes, services and business model and organizational structure of healthcare industry is the continuous rise in the cost of healthcare delivery across the globe, especially in the developed countries. Apart from ageing populations, the high cost of operations, labour scarcity, technological advancement, and poor financial performance are some of many well-recognized challenges that are contributing to the ever-increasing financial budget demand of healthcare industry (What, 2017). The

high cost of healthcare is, therefore, the major economic challenge facing many nations, because the healthcare budget is consuming the lion shares of many national natioal, squeezing out other vital investments and regrettably not reflecting in increases in value delivery (Rother, 2017). Hence, the healthcare industry is faced with an unavoidable transformation required for it to become a customer-centered industry that focused on value and quality service delivery at most affordable cost (Mona, 2017).

4.0 Current State Analysis

This section of this thesis reports the findings of current state analysis conducted in this study. It also, briefly describes what a CSA means and how it is conducted in this research to understand what kind of challenges are combating big-data technology in Finnish healthcare.

4.1 The Current State Analysis Approach

A current state analysis is an approach of study where a researcher employs methods to gain contemporary understanding and knowledge of the situation and environment of a case of study. CSA, which is also known as situation analysis, can be conducted through a various method of data collection, but most importantly for the purpose of giving a rich and deep understanding of the complete situation at the moment of study. Analysis of current state data gives a clearer definition of the problem and also help to identify the myths, truth and biases associated with the topic of study. It will also help to identify the failure, weakness and strengths of process, technology and study employed in identifying or solving the challenge.

Because of the need for a deep and rich understanding of the situation, both primary and secondary data are usually used in CSA. Primary are collected through interviews, observations and questionnaires conducted and coordinated by the researcher. Secondary data which are sourced from other parties rather than the researcher. These are data can be extracted from already researched documents such as company documents and manuals, are also used in order to examine the current state.

In this study, the challenges of big-data technology in Finnish healthcare were unknown, it is, therefore, necessary to do CSA, then study the existing knowledge (EK) to have a full and clear understanding. In this research, CSA was conducted using qualitative data collected via interview. The participants are good representatives of Finnish healthcare stakeholders and their selection are based on their level of expertise and years of experience

4.2 Key findings from current state analysis (Results)

This section introduces the findings of this study and the other of findings following the order of by which the questions were asked in the interview form. The interviewees are completely anonymous; therefore, they would be categorized based on the stakeholder group they are representing in healthcare throughout this study. However, where it deems necessary, the stakeholder group of the organisation (Not the name) would be mentioned to make room for more clarifications.

Table 1 Anonymous list of the Participants

S/N	Stakeholder Group		Profession	Years in Present Organisation
1	Medical/Health Researcher	MR	Research Coordinator	6
2			Medical Researcher	4
3			Biomedical Scientist	3
4			Lab Scientist	5
5			Research Team Leader	2
6			Senior Researcher	2
7			Researcher	4
8	Health Technology	HT	Data Scientist	3
9			Data Scientist	5
10			Data Engineer	3
11			Chief Scientist	15
12			Data Scientist	8
13	Health Worker	HW	Nurse	6
14			Pediatrician	7
15			Physician	8
16			Medical Staff	12
17			Physician	5
18	Pharmaceutical Company	PC	Data Scientist	3
19			Researcher	6
20	Health Insurance	HI	Customer Financial Officer	6
21	Government (Regulatory)	GR	Supervisor Team Head	7
22	Government (Payer)	GP	Customer Representative	6
23	Financial Institution	FI	Head, Risk Management	5

The anonymous list of the 23 interviewees that participated. Medical/Health researchers are the most highly represented with 7 participants, followed by the Health Technology and Healthcare workers with 5 participants each.

The 23 interviewees of this study came from Health Technology (HT), Health Insurance (HI), Pharmaceutical Company (PC), Medical/Health Research (MR), Health Worker (HW), Government Regulatory (GR) and Government Paying (GP) bodies; which is a good representation of almost all stake holders of the Finnish healthcare (FIGURE 7A). Table 1 shows the roles/positions and years of experience for each interviewee at their respective organisations.

4.2.1 Understanding of Bigdata

To understand how the term 'big-data' is understood by our correspondents, and to be sure that our correspondents understand the concept of big-data good enough, all correspondents were asked to define the term big-data. Their answers showed that all of them have good knowledge of the world 'big-data' but, as expected, with diversified views and ideologies. Their definitions reflect more of their profession and area of practise. However, almost all of them defined big-data by the 3V's (Volume, Velocity and Variety). These definitions emphasize the volume, velocity and variety, showcasing their good background knowledge and understanding of academic literature of big-data.

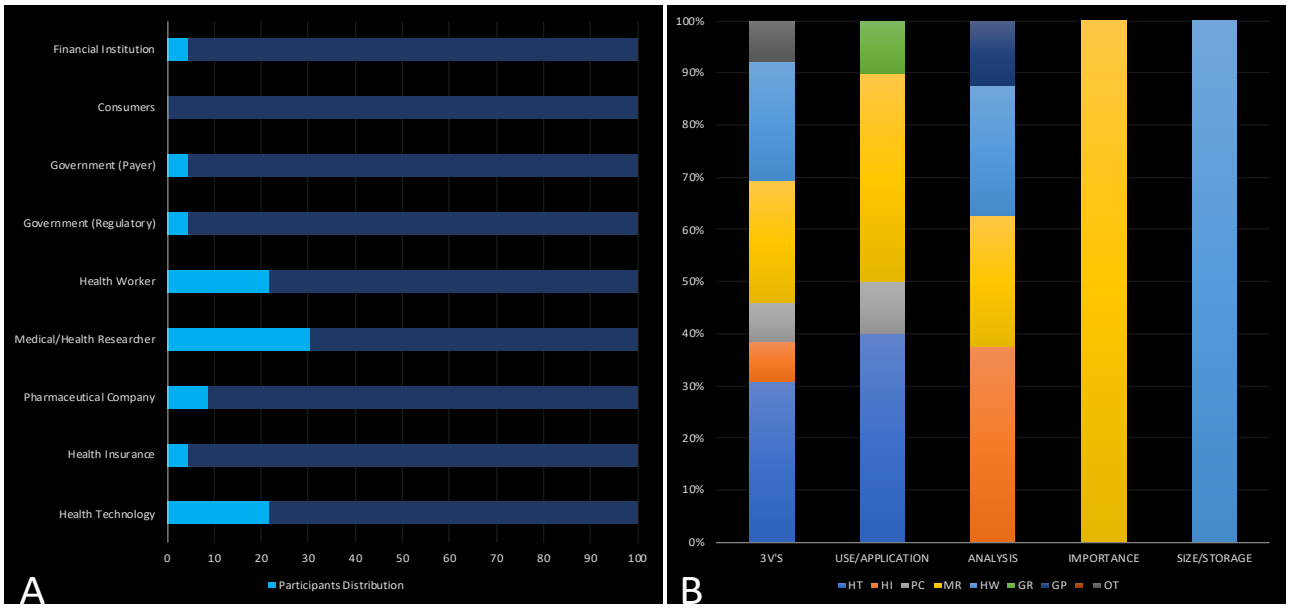

Figure 7A (The distribution of the interviewee (in Percentage) according the organisations) and Figure 7B (Key Terms Usage in the Definition of Big-Data by the interviewees)
Figure 7A depicts the distribution of interviewee according to the organisation/sector represented. **Figure 7B** is represents how each interviewee defined big-data.

FIGURE 7A shows the distribution of the 23 interviewees according to their sector/shareholder they represented in the Finish healthcare. An interviewee from Medical/Health Research (MR) have the highest number of 7, representing 30.4%; followed by interviewees from Health Technology (HT) and Health workers (HW) with 21.7% representation each. Representations from Government regulatory (GR) and Government paying (GP) bodies, and Health Insurance (HI) have

the lowest level of participants. Apart from definition according to the 3V's of big-data, some interviewee makes their definitions to narrate the use, the importance, the analysis and the storage/size of big-data. FIGURE 7B shows how the interviewees defined big-data using these terms. 3V's were used by almost all the interviewee, the exception of interviewee from GP. The definition that describes the importance of big-data and size/storage requirements of big-data was only from MR and HW respectively. Majority of the interviewee that describes big-data more about its application and usage was from HI.

4.2.2 Assessment of Big-data Success

Healthcare industry has been long identified with numbers of challenges, some of which are peculiar to the industry. Top of the list of these challenges includes a continuous rise in the cost of healthcare, Data security, ageing populations, diseases outbreak, and labour scarcity. Apart from these, there have been emerging threats like a change in customer behaviour and expectations. Our interviewees were engaged to do the assessments of big-data analytics as a solution to some of the highlighted problems. They were first asked whether big-data could be the solution to some of the healthcare challenges. On the scale of 1-5, ranging between strongly disagree (SD), Disagree (D), undecided (NT), Agree (A), and strongly agree (SA), nearly all our interviewee strongly agreed (FIGURE 8A) that big-data could through provide solutions to some of the contemporary challenges of healthcare. When quizzed further, one interviewee alleged: "It has been main tools for all achievements. Every methods, services and technological innovations in healthcare are rooted in analysis and application of big-data analytics".

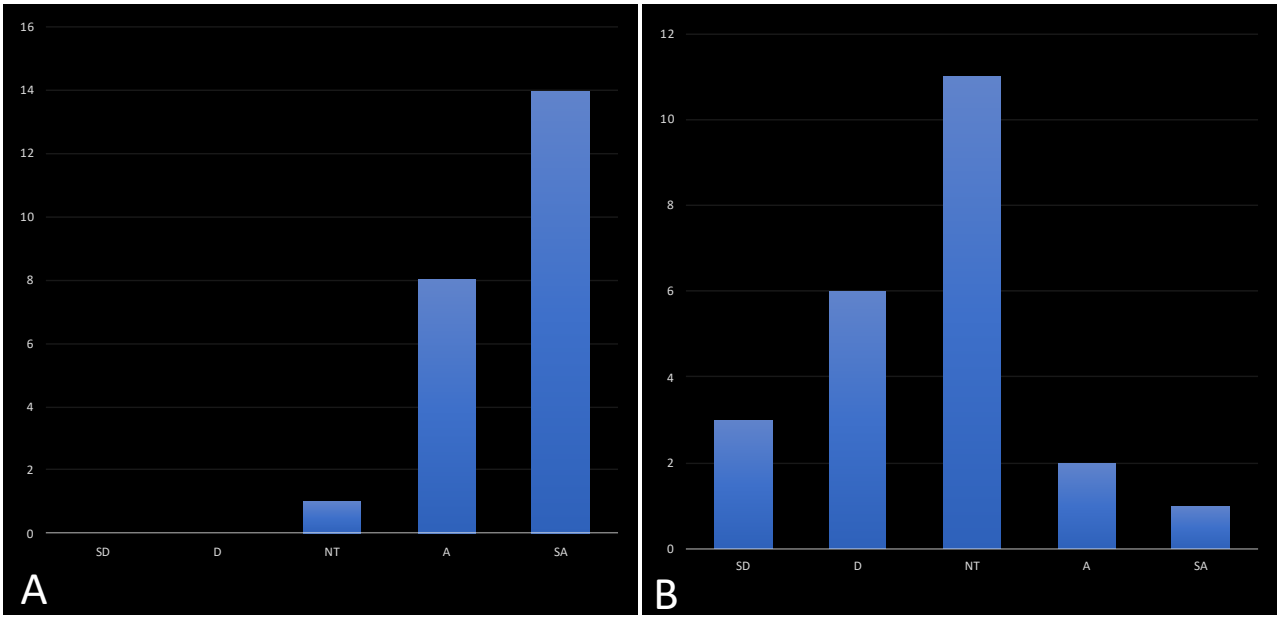

Figure 8A (Big-Data Analytics Support in Solving Healthcare Challenges) and Figure 8B Comparison of Big-Data Analytics in Healthcare to other Service industries).
The Figure 8A showed that more 60% of the interviewee strongly believed that big-data analytics can truly help in solving most of the healthcare challenges while non-disagree. **Figure 8B:** Shows that about 26% believe that the notion that big-data analytics in healthcare is lagging behind while 13 % strongly disagree with the notion. However, about 8% and 4% participants agree and strongly agree with the notion.

Big-data has been the biggest game-changing and paradigm shift in almost all industries, especially in servicing industries. Marketing and customers services have completely changed. New, better and economically viable business models are continually springing up every day, however, these benefits or the improvements visa-a-vis big-data are more pronounced in one industry than the other, depending largely on certain factors. Interviewees were allowed to assess the success of big-data in healthcare in comparison to other service industries like banking, transportation, hotel and humanities industries. Many of them mentioned that achievement and progress of big-data are lagging behind when compared to these industries; they made reservations that healthcare is unique, based on the nature of her service, customers and data it generates. There are also claims, that the implementation of new technologies is traditionally slow in healthcare, therefore, big-data is doing okay based on the ethics of healthcare. However, when asked to compare to other service industries, majority aligned to be indifferent 47.8%, while 26.1% and 13.0% interviewee agreed and strongly agreed that big-data technology is strongly lagging behind when compared to other service industries. (FIGURE 8B).

Majority of interviewees (80%) from Health and Medical research and all the healthcare workers interviewed declined to make a comparison between big-data in healthcare and other service industries; they said there is no basis for this comparison and it is, therefore, not necessary. Their assertions were the uniqueness of healthcare, especially the complexity of numbers of professionals involved and the sensitivity of data generated.

4.2.3 Future of Healthcare with Big-Data Technology

In literature and practice, efforts to combat most of the identified challenges of healthcare have been by intensified medical research and medical technology. These efforts are geared towards realization and perfection of systems to reduce the cost of research, the discovery of pharmaceutical products, and ultimately reduction in the cost of treatments. To achieve this, in recent years, there have been several changes and proposals for different kinds of treatments, methods and procedures, technically and fundamentally known in healthcare. These include Personalized Medicine, mhealth, Telemedicine, Electronic Health records (Kanta) etc.

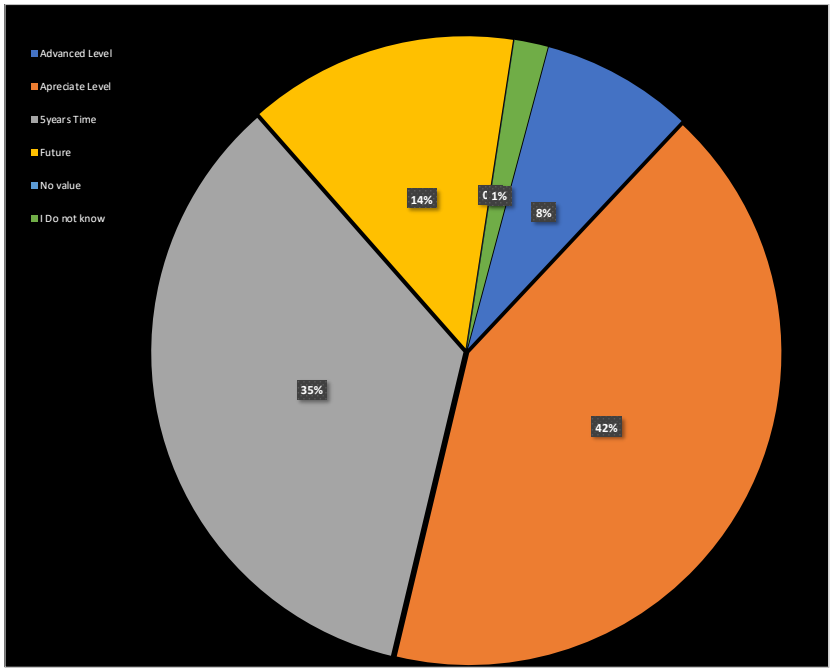

Figure 9: Big-Data Values in Healthcare
The chart above depicts the level of support that big-data technology is contributing to help in solving healthcare problems.

The interviewees were asked about the values that Big-data can create, in Finnish healthcare, to possibly provide solutions to some of the identified challenges through any of the systems highlighted above. They were guided to speak about their opinion on how and when big-data can help to achieve the highly envisage success through any of Personalized Medicine, mobile Health, Telemedicine, Responsiveness, Reduction in cost of treatments, improved quality care and customer-centered service. The opinions of our correspondents are highly unanimous on the grand role of big-data could play in adding values to Finnish healthcare through Personalized Medicine, mobile Health, Telemedicine, Responsiveness, Reduction in cost of treatments, improved quality care and customer-centeredness; however, their opinions are highly divided about when this could be achieved. On average, the results of our discussion showed (FIGURE 9) that effects of big-data in creating values in Finnish healthcare is in appreciate level, this is indicated by 41.7%. 34.8% of them feels the effects would be more effective/ pronounced in the Next five years; while 14% feels that the future that belongs to big-data in healthcare is not yet here. Surprisingly, 7.8% of our correspondents argued that big-data effects are already in an advanced level of creating values for Finnish healthcare.

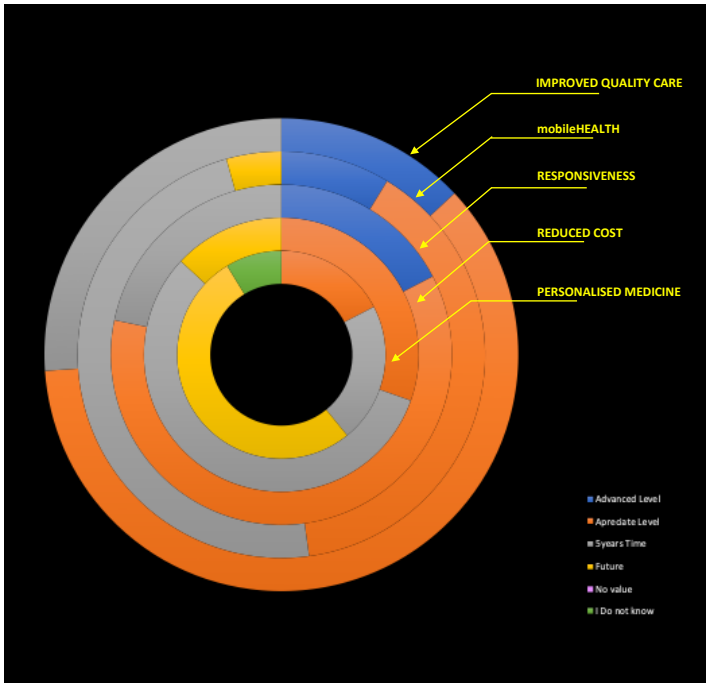

Figure 10: The levels of Big-Data Contribution in Healthcare.
Big-data have been creating values in healthcare through modern care delivery developments. Our interviewees agreed that Big-data is already at appreciate level in the development of improved quality care delivery and mobile health and responsiveness to patients care needs.

A further investigation shows that big-data is expected to produce value through PM in future (FIGURE 10). About 2/3 of our interviewees agreed and argued that big-data is already at appreciating level in responsive treatments and improved level of quality care services. Reduced cost of healthcare is another value that our interviewees believed would be greatly affected in no more than five years' time.

Predictive medicine, Time and labour management, engaged treatment, digitization of process and methods etc. are some of the other benefits that are sacrosanct with big-data in healthcare. Majority of interviewees from MR feel predictive medicine is a one benefits of big-data that is already at appreciate level and it has proven to be a huge relief to much of financial burden of healthcare.

4.2.4 Big-Data in Finnish Healthcare

Globally, Finnish healthcare is highly rated and is one of the leading countries in modern healthcare delivery. In order to understand the role, if there is any, of big-data in this success story of Finnish healthcare; we probed the minds of our interviewee with the question:

> "*Finnish healthcare and health technology have been regarded among the best in the world. How would you as person, in the industry, describe big-data analytics as a contributing factor, if there is any"*

All our interviewees were strong in their assertions that the success level of Finnish healthcare of today is based on the technical know-how of the country, which by all standard, is highly connected with the early adoption and investment in information and mobile technology. They argued that the success of Finland in healthcare delivery is majorly because of its breakthrough in health technology which was argued to be more successful because of big-data analytics. There is good agreement across the interviewees that data scientist is integrated as part of healthcare and medical research; and this has been fundamentally good for developments in healthcare delivery, for example, one interviewee said " This is very true because Finland's data research science is highly coordinated with all health and medical research, and more reasons why the data from all these researchers have been maximized for interventions and developments of tech and treatment models" and another person corroborated saying "Everything achieved, I believed is all cooperative efforts from all areas of research in medical, health and data science. It is owed very importantly to the accessibility and usage of data by data scientist"

One of our interviewees, a senior researcher from Medical and Health research institute, wrote "It has been the huge wheel behind most of the health tech and medical success stories of Finland, supposed I'm right. This is because of huge investment in data research and databank, especially medical data research. But most importantly the access granted for the use of data".

Another significant part of their assertions, especially for the interviewees from health technology and medical research, is that, even though big-data analytics is important now in healthcare, it would still become more important in the future, because of its roles in digitization, artificial intelligence (AI) etc.

4.2.5 Barriers of Big-Data in Healthcare

Based on our findings from the assessment of big-data in Finnish healthcare in section 3.2.2 above, through which we discovered, according to the answers and comments from most of our interviewees, that despite its huge contribution to the achievements of Finland in health technology and healthcare delivery, big-data performance could still be regarded as underperformance, when compared to its achievements in other service industries. We, therefore, decided to ask our interviewers to itemize factors they considered as barriers or a delay to the actualization of the full potential of big-data analytics in Finnish healthcare against their expectations.

All the interviewees acknowledged that data privacy and security issues as a major challenge but most strongly argued that the government roles about the data security issues make it more challenging for big-data technology. The majorities mentioned the strictness of regulatory policies and laws about health data use in big-data analytics makes data less accessible for them. FIGURE 11 showed the frequency of barriers identified by all interviewers.

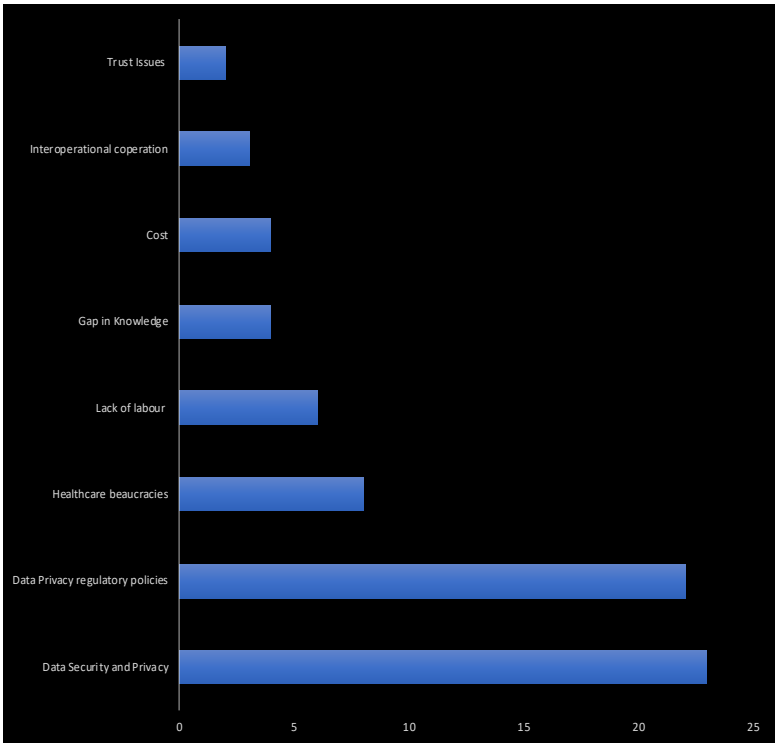

Figure 11: Barriers to Big-Data Analytical Advancements in Finnish Healthcare Industry.
All participants agreed that data security threats remain number challenge, but locally, the government regulatory policies pose more challenges. Costumers' trust issue is the most less- considered to be a challenge.

All of them were quick to mention data privacy and security as a major barrier, but there is a major difference in the number of people that think lack of trust from the patients, even when they were asked if trust could be one factor. Only 8% agreed that trust issues could be a factor that hinders the accessibility of data, but this notion, however, counteracts, especially by the healthcare worker interviewees and health researchers, they mentioned that Finnish people trust their health institutions and freely give access for use of their data under the legislation. One interviewee wrote, "*In Finland, Patients do trust and when they want to trust, they really don't know who to trust. This is because the healthcare institutions are highly harmonized and regulated by the government, more so, the government is the payer, so Finns tends to trust their system more compared to other society*"

About the government roles as a barrier, a data analyst with 15 years' experience in the industry write "Availability of patient data for the development work is the biggest issue. There is data, but it is not available for Developers" He tried to explain that legislation makes data available to be more difficult to what the patients actually profess. In an example of this, a Research Team leader

in Medical research said "*Legislation: the secondary use of health information is still in the Parliament. Uncertainty related to health care reform (SOTEuudistus). Fragmented data repositories, large numbers of health information systems, interoperability cooperation between the data owners, some of these are the real big threats and barriers*"

4.2.6. Possible Solutions

Finally, our interviewees were asked to mention and also give a brief explanation of possible solutions to some of the identified problems they have mentioned in 3.2.5 above. As expected, most of the solution tactics were geared towards the issue of data security and privacy issues. However, some interviewee proffers the solutions to cater to the informational gap between the expertise in healthcare.

Some of the main solutions mentioned by most interviewee include the making of less restrictive and complex regulations for the data used by data scientist, making of clear rules of data anonymization, making of healthcare data automatically anonymous and readily accessible for data scientists. The creation of a data lake, with the contents that are already anonymous and available of every use, was proposed by a data scientist. The use of, perhaps some type of "sandbox" requirement for the IT systems where analysis must be done but that it would be difficult to get masses of individual-level data out, also was another technical solution proposed by another data scientist.

One interviewee wrote "Data technology and big-data technology should be made understandable to the public. To at least make a good number of people understand and appreciate the benefits in allowing the use of data for analytical research" while another solution cared about bridging the gap in knowledge between the data scientist and other professionals in healthcare. An interviewee argued that all shareholders in the industry, particularly the healthcare works should be made to have the fundamental or basic updated knowledge of big-data analytics and technology in healthcare.

5. Discussions and Recommendations

This section will discuss the findings from the current state analysis and the background studies form literature. The results of the findings would be discussed in lights of the existing knowledge, to fully gain the insights of the currents situations of the problems identified and possible applicable solutions. Finally, this section will recommend possible solutions to the identified problems according to the studies. The recommended solution would be the final recommendations of this study.

5.1 Discussions

Big-data technology has been a very hot topic in academic and business circles for almost a decade now, not only in healthcare but in almost all sectors of an economy (Langkafel, 2015). However, in healthcare, these discussions have never been in isolations from some impeding factors that are hindering the treasure and economic values that big-data campaigners always profess. (Digital Enterprise 2016; Jee and Kim, 2013; Kruce et al., 2016). Undoubtedly, big-data analytics has been a driving force in technology and businesses, and it has shifted the paradigm of everyday business completely since we are now in an era of data.

Coincidentally, Healthcare industry is an industry that generates lots of data, and also of pertinent challenges, but more importantly, deals with a customer that has greatly changed in behaviour over the last decades due to information technology advancement. It is a sector that is shaped by global trends which call for new approaches for care and models. These, therefore, make big-data technology to appear, to be so appropriate solution routes to some of the challenges in healthcare (Feldman et al., 2012; Frost, 2012). However, less has so far been achieved, despite the huge investment of resources and several policies implementations.

Globally, some factors have been highlighted to be barriers to the envisaged achievements of big-data in healthcare. In this study, we carried out studies to identify the barriers of big-data analytics in Finnish healthcare and the possible applicable local solutions. Our study was carried out by engaging the professional stakeholders in healthcare and based on their experience, they helped in identifying some of the problems and the possible ways to ameliorate the challenges. The studies involved 23 participants who are professionals in the industry, with an average of 6 years working experience in Finland. These participants who were selected based on their area of expertise were identified through an online search, from the company website, academic journals publication, LinkedIn etc. The knowledge and understanding of the topic and issue of discussion by the participants were tested, and it was confirmed, that they have a pool of knowledge about the topic and the field of study. They all give their version of the definition of big-data as a term and went on to justify their representation with some logical and technical answers provided to some of our questions.

Against the public opinion that big-data is lagging behind in achievement when compared with other service industries (Gillette, 2004; What, 2017), our participants said, in Finland, big-data in healthcare has been tremendously adopted and it has helped to push Finnish healthcare delivery to an enviable spot in the world, though, some agreed that much is not yet achieved as compared to other industries, but due to the peculiarity of healthcare, a system that deals with highly sophisticated process, life of humans, complex and complicated confluence of professionals, a very meticulous process of adoption of any technology is highly inevitable, and this explains reason why adoption of new technology is always sluggish in healthcare. The result from our findings showed that big-data is much more integrated into healthcare and serves as a fulcrum and the reasons that make some of the newly introduced (e.g. SOTE) health policies to be possible. However, compared to what is obtained in the literature, findings completely agreed that large percentages of identified challenges in healthcare can be catered for through the use of big-data analytics. All our participants boldly argued that big-data can engineered solutions to most of the problems that are currently challenging the healthcare, just as mentioned by Kruce et al. (2016); resources management, labour scarcity and increasing cost of treatment can all be quietly managed by use of current data produced in healthcare.

Also, compared to the most other parts of the world, where big-data is not expected to be creating values in healthcare until after five years; especially in areas like mobile health, Electronic Health

records, and improved care quality; Finland is already at the appreciating levels (FIGURE 10) in all these areas. All these are pointers that big-data is not struggling to deliver in healthcare compared to how it is usually publicised. However, there is still a large room for development, in the area of security. Our study also showed that there is a need to shun any comparison between the big-data analytics' achievements or integrations pattern of Healthcare industries and other service industries. Though several studies have shown, that when this comparison is done, healthcare big-data analytics appeared to be lagging behind in achievements, projecting the area of technology as vague and hyphae, hence a waste of resources (Gillette, 2004; What, 2017). Instead of this, our studies showed that big-data has been highly successful in healthcare and there is no basis for comparing it with other service industries. The arguments lie in the fact that, healthcare data is very precious and valuable than, any known that from any other industries. Aside from this, healthcare data are exceedingly voluminous, with high generating velocities and great variability of contents. The later combined with the unique nature of healthcare service requirements and the complexity in compositions of her stakeholders, professionals and the consumers; give no room for these comparisons.

It is also evident, from the study that big-data analytics is playing pivotal roles in the current upsurge of Finnish healthcare standard. The system in Finland has greatly invested in mobile technology and information technology but most importantly integrated, she has integrated data science into the fold of health and medical and translational medicine research. Finland is proud of the biobank, it is a great resource of big-data in healthcare, which has made it possible to have genomic information from the physical sample into digitalized healthcare information and enable self- longitudinal studies of endemic and life-threatening diseases. The Project Way Forward of Finpro's Team Finland Health growth program is one program that clearly defined how the Finnish government is committed to the use of big-data technology in healthcare. Identifying and utilizing her strengths in medical research, communication technology, health technology and health data. The engagement of big-data technology has made Finland to become one of the leading countries that, through her universal identification number, universal healthcare system number and innovation-friendly regulation system, have been able to build a high quality and comprehensive national health data in a digital format

Despite the acknowledged the roles and contributions of big-data analytics to the success story of Finnish healthcare, our findings still show that there are certain barriers which have been preventing

the technology attain the level of success envisaged some years back, fortunately, some of these identified barriers can be addressed. According to the works of literature, there is a long list of challenges/barriers that are combating big-data technology in healthcare; in contrast to this, big-data in Finnish healthcare is combated with majorly the issue of government's regulatory policies on data privacy and security. The findings of this thesis, gathered from the expertise of different areas of Finnish healthcare showed that commons issues (like the trust issue, data ownership, storage, and cost) that challenge the success of big-data in healthcare in other economies, seems to hold no ground in Finland (FIGURE 11). However, there is a need for government to lessen the restrictions of legislation that guide the access of data scientists or researchers to the available data, to portray the trust the Finnish public have in their health research. Apart from bureaucratic government policies and legislation, the threat on data safety and cyber-attacks were also mentioned. There is generally a dispel from all our participants when the issue of trust by consumers was raised, unlike other societies, Finns are willing to submit their data for research and academic purpose without the issue of trust, this has enabled the collection of millions of health records and sample collections.

5.2 Recommendations

The investigations of this study have shown fewer numbers of barriers to be confronting the success of big-data technology, compared to what is globally declared. However, the identified barriers in this study were part of the contemporary problems in a global context. The findings of this studies, which includes the findings from both the applied research methods of interviewing the experts and stakeholders of Finnish healthcare and the qualitative data from literature review, would be used to propose some possible applications solutions to the identified challenges of Finnish healthcare's big-data technology.

Though many solutions were recommended and argued for by our various participants; but after studying and analysing other data and findings; this study would like to recommend that government should look more closely in the policies that guide the access and usage of data for big-data analytics and inventions. Presently, there is a lot of restriction clauses that put very big limits to certain uses of health data. The risk of data leak or data theft can lessen or avoid by introducing a system of automatic anonymization of data from the point of generation.

As mentioned above, it is recommended that a process that will systematically anonymised and transform data into a data lake and made available for data research with fewer restrictions. This will reduce the current difficulty and multiple bureaucratic administrative processes of regulations. It will also prevent using of government funds and resources in providing security to prevents on the health data. There is also a need to put a legislation in place to support access to data for innovative small entrepreneurs (SMEs) and start-ups.

6 Conclusion

This section concludes the thesis work, hence the name. The earlier chapter discussed the results of the research. It also presents the recommendations to the identified challenges of big-data analytics in the Finnish healthcare industry. This chapter will, however, summaries the findings of this study. Furthermore, the limitations of the thesis would be discussed and finally the suggestions for further research.

6.1 Summary

This study used an applied research method to investigates the possible barriers that could be mitigating against the success of big-data analytics in Finnish healthcare. The work of the study also involves the identification and proposition of possible solutions to the identified mitigating factors. The study was carried by using the applied method to do the current state analysis. The professionals of the stakeholder's sectors were chosen as the contacts for remote interviews.

This study established that the highly restrictive government regulatory policies of data privacy and security are one major challenge that is limiting the full potential of big-data analytics in Finland's healthcare industry. Apart from this, there are other factors, like threats of data security bridge and attacks. The study shows that these other factors put fewer limitations on the activity of big-data analytics compared to government policies.

This study concludes based on its findings, that the benefits of big-data analytics and technological innovations can be maximised; If the government legislation could be less restrictive and more legally accessible for data scientist and researchers. Therefore, this study suggested, among other options, for the systemic automatic anonymization of data to make it less attractive to cyber-attacks. The study, therefore suggests for the automatic systemic anonymization of data that would make health data to be less attractive to attacks.

6.2 Ethical Considerations

This research follows all the ethical principles recommended for the research studies in humanities, and social and behavioural sciences by the Finnish National Board on Research Integrity (TENK) informed consent, all interviewees were informed of the background and purpose of the research as well as how and why they had been chosen as participants for the study. The participation was made to be voluntary and all interviewees were given enough time to respond without coercion.

An informed consent letter was sent to all participants, with instructions on how to assess the publication from the collected data on the university library page. They were also assured of data protection and anonymity in writing. Moreover, the questionnaire (Appendix C) was designed to be completely anonymous and data were also analysed anonymously.

For the purpose of openness and validity of the study, the questionnaire was designed to capture date and time. In respect to the section 3.2 of TENK recommendations, and also, because the research data does not contain the primary identifier, they would be stored for the purpose of verifications and cross-examinations until the approval of the study before destructions.

6.3 Limitation of the Research

Despite the good findings of this study, for the purpose of the validity and reliability of this study; it is highly imperative to mention the limits of this study. The number one limitation of this study is the numbers of participants. Though the researcher planned to cover a wider and highly diverse number of correspondents, that will be a good representation of all the stakeholders. However, the response rate was low and limited.

Due to the profiles of interviewees required for this study, it was very difficult to successfully organise face-to-face interviews. We, therefore, resolved to the use of online questionnaire form interviews. Inability to conduct a face-to-face interview is considered as another limitation of this study. Apart from the known disadvantages of questionnaire method, other aspects of the data collection method were well-taken-care-of, and all the respondents that participated cooperates accordingly and show good interest and readiness to give exhaustive answers and information.

6.4 Suggestion for Further Research

This study tries to gain an insightful knowledge about the possible issues surrounding the adoption, integration and application of big-data technology in the Finnish healthcare industry. It is a very

However due to the limitations of the study, as highlighted in section 7.2 above, the author would like to recommend a further and comprehensive research, the study can use the result of this study as the basis for the objective and method design. Considering the identified problem and solution, further research may require a technical study, that would involve the development of a method for automatic anonymization of data suggested as a solution in this study.

7 Reference

Amirian, P., Lang, T. and Van Loggerenberg, F. eds., 2017. *Big Data in Healthcare: Extracting Knowledge from Point-of-Care Machines*. Springer.

Amirian, P., van Loggerenberg, F. and Lang, T., 2017. Big Data and Big Data Technologies. In *Big Data in Healthcare* (pp. 39-58). Springer, Cham.

Archenaa, J. and Anita, E.M., 2015. A survey of big data analytics in healthcare and government. *Procedia Computer Science*, *50*, pp.408-413.

Baker, T.B., Gustafson, D.H. and Shah, D., 2014. How can research keep up with eHealth? Ten strategies for increasing the timeliness and usefulness of eHealth research. *Journal of medical Internet research*, *16*(2).

Balakumar, P., Inamdar, M. N., & Jagadeesh, G. 2013. The critical steps for successful research: The research proposal and scientific writing: (A report on the pre-conference workshop held in conjunction with the 64th annual conference of the Indian Pharmaceutical Congress-2012). *Journal of pharmacology & pharmacotherapeutics*, *4*(2), 130.

Balan, S. and Otto, J., 2016. Big Data Analysis of Home Healthcare Services. *Information Technology and Management Science*, *19*(1), pp.53-56.

Benbasat, I., Goldstein, D.K. and Mead, M., 1987. The case research strategy in studies of information systems. *MIS quarterly*, pp.369-386.

Bernard Marr 2016. Big Data in Healthcare: Paris Hospitals Predict Admission Rates Using Machine Learning. *Forbes (Tech)* [Online] 13 December 2016. Available at: https://www.forbes.com/sites/bernardmarr/2016/12/13/big-data-in-healthcare-paris-hospitals-predict-admission-rates-using-machine-learning/#4dd33ccb79a2 (Accessed. 07 July, 2018)

Bhatt, C., Dey, N. and Ashour, A.S. eds., 2017. Internet of things and big data technologies for next generation healthcare.

Brent Shafer, 2014. A new business model for a better future. Philips innovation matters. [Online] April 2014. Available at: https://www.philips.com/a-w/about/news/archive/blogs/innovation-matters/a-new-business-model-for-a-better-future.html Accessed. 05 December 2017)

Brian Eastwood, 2013. 6 Big Data Analytics Use Cases for Healthcare IT. *CIO from IDG* [Online], April 23,2013. Available at: https://www.cio.com/article/2386531/healthcare/healthcare-6-big-data-analytics-use-cases-for-healthcare-it.html (Accessed. 05 November, 2017)

Brittany Farb, 2011. Social Media Expands the Role of the Customer. Insight. Customer Relationship Management, www.destinationCRM.com, October 2011 Available at: http://www.destinationcrm.com/Articles/Columns-Departments/Insight/Social-Media-Expands-the-Role-of-the-Customer--77660.aspx

Chawla, N.V. and Davis, D.A., 2013. Bringing big data to personalized healthcare: a patient-centered framework. *Journal of general internal medicine*, *28*(3), pp.660-665.

Chaffey Dave 2018, Global Social Media Summary 2018. Smart Insight. [Online] 28 November 2018. Available at: https://www.smartinsights.com/social-media-marketing/social-media-strategy/new-global-social-media-research/ (Accessed. 30 June 2018)

Cox, M. and Ellsworth, D., 1997, October. Application-controlled demand paging for out-of-core visualization. In *Visualization'97., Proceedings* (pp. 235-244). IEEE.

Digital Enterprise, 2016: World Economic Forum White Paper Digital Transformation of industries: In collaboration with Accenture. World Economuc Forum: Digital Enterprise [Online] January 2016. Available at: http://reports.weforum.org/digital-transformation/wp-

content/blogs.dir/94/mp/files/pages/files/dti-societal-implications-white-paper.pdf (Accessed. 06 November 2017)
Elizabeth Snell, 2017. Computer Theft Raises Health Data Security Concerns for 8K [Online] 02 November 2017. Available at: https://healthitsecurity.com/news/computer-theft-raises-health-data-security-concerns-for-8k (Accessed. 05 July 2018)
Environment of Finland. [Online] 16 November 2016. Available at: http://www.finlandhealth.fi/documents/62524/319237/Project+Way+forward_Final+report_Executive+summary/66ccf940-79bc-43ad-be1c-70e5f5ba3e4b (Accessed: 30 May 2017)
European Commission (2015): Questionnaire on European Data-Driven Economy. [Online] 01 September 2015, Available at: http://old.cema-agri.org/newsletterarticle/input-wanted-eu-consultation-data-driven-economy (Accessed: 06 November, 2017)

Export, 2017. Finland- Medical equipment and Health Technologies. The U.S. Department of Commerce's International Trade Administration [Online] 15 August 2017. Available at: https://www.export.gov/article?id=Finland-Medical-Equipment-and-Healthcare-Technologies (Accessed: 07 July 2018)
Feldman, B., Martin, E.M. and Skotnes, T., 2012. Big data in healthcare hype and hope. *Dr. Bonnie*, *360*, pp.122-125
Finland Health (a), 2016. Finland's Biobanks offer the big data medical research will need for pesrobalised medicine. [Online] 09 November 2016. Available at: https://www.investinfinland.fi/web/finlandhealth/-/finland-s-biobanks-offer-the-big-data-medical-research-will-need-for-personalized-medicine (Accessed: 06 July 2018)
Finland Health (b), 2016. Finland <3 Science. [Online] 01 August 2016. Available at: https://www.investinfinland.fi/web/finlandhealth/-/finland-3-science (Accessed: 06 July 2018)
Finland Health, 2016. EY widescreen presentation: The Future Healthcare Innovation
Finland Health, 2016. Finland's healthcare system- Europes's highesr satisfaction ratings. [Online] 09 November 2016. Available at: http://www.finlandhealth.fi/-/finland-s-healthcare-system-europe-s-highest-satisfaction-ratings (Accessed: 30 June 2018)
Flanders, 2017. Health Technology in Finland. Flanders Investment & Trade. Health Tech: FIT Helsinki [Online] June 2017. Available at:https://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/Smart%20Cities_Finland_2017.pdf (Accessed: 07 July 2018)
Frost, S., 2012. Drowning in big data? reducing information technology complexities and costs for healthcare organizations.
Gartner 2018. Big Data. Gartner:IT Glossary. [Online] Available at: https://www.gartner.com/it-glossary/big-data/ (Accessed. 06 July 2018)

Gordon, J., Perrey, J., & Spillecke, D. 2013. Big data, analytics and the future of marketing and sales. *McKinsey: Digital Advantage*.
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.
Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B. and Akter, S., 2017. Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, *70*, pp.308-317.
Helms, M.M., Moore, R. and Ahmadi, M., 2008. Information technology (IT) and the healthcare industry: A SWOT analysis. *International Journal of Healthcare Information Systems and Informatics (IJHISI)*, *3*(1), pp.75-92.

Humer, C. and Finkle, J., 2014. Your medical record is worth more to hackers than your credit card. *Reuters. com US Edition*, *24*.
Invest in Finland, 2016. Finland- The best place for data. [Online] 22 November 2016. Available at : https://www.investinfinland.fi/-/finland-the-best-place-for-data (Accessed: 06 July 2018)
James Collins, 2016. Lecture 1: Research Skills and Methods, Lecture slides 1 (S000CF89-3002), Helsinki Metropolia University of Applied Science (Delivered: 01 September 2016)
Jee, K. and Kim, G.H., 2013. Potentiality of big data in the medical sector: focus on how to reshape the healthcare system. *Healthcare informatics research*, *19*(2), pp.79-85.
Julia K. (2015), IT Road Map: Healthcare Customer Service Takes Centre Stage. Computer world
Karen Taylor 2015. Connected Health: How digital technology is transforming health and Social care. Deloitte Centre for Health Solutions. Available at: www.longwoods.com/articles/images/deloitte-uk-connected-health.pdf
Knowlegent (2015): 2015 Big Data Survey: Current Implementation Challenges. Knowledgent [Online] 2015. Available at: https://knowledgent.com/whitepaper/2015-big-data-survey-current-implementation-challenges/ (Accessed: 06 November, 2017
KPMG, 2015. Healthcare Insights: Turning data into patient value, [Online], Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/.../healthcare-insights-dec-2015-2.pdf (Accessed. 05 December 2017)
Kruse, C.S., Goswamy, R., Raval, Y. and Marawi, S., 2016. Challenges and opportunities of big data in health care: a systematic review. *JMIR medical informatics*, *4*(4).
Langkafel, P. ed., 2015. *Big data in medical science and healthcare management: Diagnosis, therapy, side effects*. Walter de Gruyter GmbH & Co KG.
Lincoln, E. and Guba, E., 1985. Naturalistic Inquiry. California, Estados Unidos.
Local Finland, 2017. Expert services: Finnish municipalities and regions [Online] 16.February 2017. Available at: https://www.localfinland.fi/expert-services/finnish-municipalities-and-regions (Accessed: 30 June 2018)
Marr, B., 2015. *Big Data: Using SMART big data, analytics and metrics to make better decisions and improve performance*. John Wiley & Sons.
Melkas, T., 2013. Health in all policies as a priority in Finnish health policy: a case study on national health policy development. *Scandinavian Journal of Public Health*, *41*(11_suppl), pp.3-28
Merriam, S.B. and Tisdell, E.J., 2015. *Qualitative research: A guide to design and implementation*. John Wiley & Sons.
Minelli, M., Chambers, M. and Dhiraj, A., 2012. *Big data, big analytics: emerging business intelligence and analytic trends for today's businesses*. John Wiley & Sons.
Ministry of Social Affairs and Health, 2013. Health care in Finland.
Mona Lebied 2017. 9 Examples of Big Data Analytics in Healthcare That Can Save People. *Datapine* [Online], May 24, 2017. Available at https://www.datapine.com/blog/big-data-examples-in-healthcare/ (Accessed. 05 November 2017)
Morris, M. and Yoritomo, W., 2015. Global health care outlook: Common goals, competing priorities. *Deloite, USA*.
Nicholas Davis 2016. What is the fourth industrial revolution*? World Economic Forum* [Online] 19 January, 2016. Available at: https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/ (Accessed. 06 November, 2017)
Patton, M.Q., 1990. *Qualitative evaluation and research methods*. SAGE Publications, inc.
Peter Freely, 2017. Finland leads in healthcare technology. Reports [Online] 11 December 2017. Available at: https://gulfnews.com/gn-focus/country-guides/reports/finland/finland-leads-in-healthcare-technology-1.2138649 (Accessed: 06 July 2018)

Priyanka, K. and Kulennavar, N., 2014. A survey on big data analytics in health care. *International Journal of Computer Science and Information Technologies*, *5*(4), pp.5865-5868.
Raghupathi, W. and Raghupathi, V., 2014. Big data analytics in healthcare: promise and potential. *Health information science and systems*, *2*(1), p.3.
Raghupathi, W., 2016. Data mining in healthcare. *Healthcare Informatics: Improving Efficiency through Technology, Analytics, and Management*, pp.353-372.
Robert Pearl, 2014. 5 Things Preventing Technology Adoption In Health Care. Pharma and Healthcare [Online] 11 November 2014. Available at: https://www.forbes.com/sites/robertpearl/2014/09/11/5-things-preventing-technology-adoption-in-health-care/3/#44e91a5a7724 (Accessed. 05 December 2017)
Rother, J., 2017. Top of the Administration's Agenda: Stem the Rising Cost of Healthcare. *Generations*, *40*(4), pp.30-37.
Sarwar, M.U., Hanif, M.K., Talib, R., Mobeen, A. and Aslam, M., 2017. A Survey of Big Data Analytics in Healthcare. *International Journal of Advanced Computer Science and Applications*, *8*(6), pp.355-359.
Saunders, M., Lewis, P. and Thornhill, A., 2009. *Research methods for business students*. Pearson education.
Saunders, M., Lewis, P. and Thornhill, A., 2016. *Research methods for business students*. 7th Ed. Edinburgh Gate, Harlow: Pearson education Limited.
Secure Destruction, 2018. 9 Surprising fact about medical identity theft and Healthcare security. Secure Destruction [Online] Available at: https://www.securedestruction.net/identity-theft/9-surprising-facts-about-medical-identity-theft-and-healthcare-security/ (Accessed: 06 July 2018)
Shelby Livigston, 2017. Healthcare drives yearly job growth. Modern Healthcare, [Online] 06 January 2017. Available at: http://www.modernhealthcare.com/article/20170106/NEWS/170109951 (Accessed. 30 June 2018)
Statistics Finland, 2018. Official Statistics of Finland (OSF): Labour force survey [Online].26 June 2018. Available at: http://www.stat.fi/til/tyti/index_en.html (Accessed: 30 June 2018)
Teperi, J., Porter, M.E., Vuorenkoski, L. and Baron, J.F., 2009. The Finnish health care system: a value-based perspective. *Sitra reports*, *82*.
Thielst, C.B. 2011, "Social media: ubiquitous community and patient engagement", *Frontiers of health services management,* vol. 28, no. 2, pp. 3-14.
Tuomi, J. and Sarajärvi, A., 2002. *Laadullinen tutkimus ja sisällönanalyysi. Helsinki: Tammi, 2002.-158 s*. ISBN 951-26-4856-3.
Walshe, K. and Smith, J. eds., 2011. *Healthcare management*. McGraw-Hill Education (UK).
Wang, Y., Kung, L., Ting, C. and Byrd, T.A., 2015, January. Beyond a technical perspective: understanding big data capabilities in health care. In *System sciences (HICSS), 2015 48th Hawaii international conference on* (pp. 3044-3053). IEEE.
What-when-how, 2017. Information Technology (IT) and the Healthcare Industry: A WHAT, 2017 Analysis, what-when-how: In Depth Tutorials and Information Available at: http://what-when-how.com/medical-informatics/information-technology-it-and-the-healthcare-industry-a-What, 2017-analysis/ (Accessed. 09 July 2018)

Appendices

Appendix A
Invitation email to the Participants

Request for a response to a Questionnaire

Adewale Taiwo
Tue 10/16, 10:18 AM
Adewale Taiwo; Leena.Forma@uta.fi; Ilmo.Keskimaki@uta.fi; Pasi-Heikki.Rannisto@uta.fi; Pekka.Rissanen@uta.fi;

Reply all

Sent Items

Dear recipient,

I am an MBA student of Health Business Management of Metropolia University of Applied Sciences, Helsinki. I am currently working on my degree thesis which is researching the factors compelling against big data technology in Finnish healthcare and the possible solution.

You are one of the participants selected across Finland for this interview. The selection is based on the field of expertise and experience. The information used to identify the interviewee were obtained from public domains like literature publications, company web pages, LinkedIn etc. The selection is strategically done to have a rich representation of the Finnish healthcare shareholders.

I will really appreciate if you can create time to share your knowledge on this topic, as your participation would be valuable and highly appreciated. If you agree to participate, kindly click on this link to access the questionnaire.

The interview will take about 20mins. It has a voice prompt with which you can answer the question; however, if you don't what to use the voice prompt, there are options for type your answers. By default, participation in this interview is anonymous. Responses will be analysed so that no individual person or organization can be identified. The findings will be available at Metropolia's library upon the completion of the Thesis project.

Thank you so much as I look forward to your supportive response.

(You can also copy clipboard https://form.jotformeu.com/81932355829365 and paste on the browser to access the form)

Sincerely,
Taiwo Adewale David
adewale.taiwo@metropoli.fi
0469361349

'Wale TAIWO
Helsinki Metropolia University of Applied Sciences,
Helsinki,
FINLAND
+358(0) 46 936 1349
www.metropolia.fi
adewale.taiwo@metropolia.fi
dwaletaiwo@gmail.com

"The ultimate measure of a man is not where he stands in moments of comfort and convenience, but where he stands at times of challenge and controversy."
– Martin Luther King Jr.

Appendix B
Reminder Email

Request for a response to a Questionnaire (Reminder)

Adewale Taiwo
Mon 10/29, 9:31 AM
0_placeholder; Leena.Forma@uta.fi; Ilmo.Keskimaki@uta.fi;

Reply all

Sent Items

Dear Correspondents,

This is a soft reminder about the survey you received on Tuesday 12.10.2018. If you have not responded, kindly help to do so. Your response is of high value to this study and would be highly appreciated.

Once again, here is the **link** to the survey. *(You can equally copy clipboard https://form.jotformeu.com/81932355829365 and paste on the browser to access the form)*

Regards,
Taiwo Adewale David
adewale.taiwo@metropoli.fi
0469361349

'Wale TAIWO
Helsinki Metropolia University of Applied Sciences,
Helsinki,
FINLAND
+358(0) 46 936 1349
www.metropolia.fi
adewale.taiwo@metropolia.fi
dwaletaiwo@gmail.com

"The ultimate measure of a man is not where he stands in moments of comfort and convenience, but where he stands at times of challenge and controversy."
– Martin Luther King Jr.

Appendix C
Questionnaire form

Big-Data Technology in Finnish Healthcare: Barriers and possible ways out

This questionnaire is designed to understand identify barriers that hinders big data analytics/technology in healthcare as compared to other industry, and possible solutions. You have been selected as one of the respondents based on your expertise and experience to share with your on this issue.

The outcome would be used to discuss the prospects of big-data innovations in my thesis, which planned to propose sets of recommendation to help against some of the barriers that would be identify by this study. By default, participation in this questionnaire is anonymous. Responses will be analysed so that no individual person or organisation can be identified. Thank you for your time and input.

In case your companyor organisation wishes to submit any additional input please send it to adewale.taiwo@metropolia.fi

---

Date

28-11-2018 Date at 12 Hour : 10 Minutes

1a. What category of Healthcare stakeholder do you or your organisation belong? *

Health Technology

Others, please specify

1b. How long have been on this your job/position? *

2

1c. Can you describe the services/roles of your organisation in Healthcare

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

2. How would you define the term big-data

Record ▶ Play 0:00 / 2:00

You can write instead of speaking if you like

Next

3. Big data analytics has touted to be the solution to some of healthcare challenges, how much do you agree with this?

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	strongly agree

4. Big data analytics' progress/achievement in healthcare are comparatively on the same level with other service industries like Banking, gaming, insurance, transportation. How much do you agree with this?

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

5. How would you describe/compare the success of big data analytics/Technology in Finnish healthcare to other industries (transportation, gaming, banking, aviation etc.) in Finland.

Record ▶ Play 0:00 / 2:00

You can write instead of speaking if you like

6a. In what way can big data create value in (Finnish) Healthcare.

	Advanced level	Appreciate Level	Expects to create value in about 5 years	Expects to create value in future	Does not create value this way	I do not know
Personalized Medicine	○	○	○	○	○	○
mHealth	○	○	○	○	○	○
Responsiveness	○	○	○	○	○	○
Reduced cost	○	○	○	○	○	○
Improved Quality care	○	○	○	○	○	○

6b. Suggest other benefits of big-data in healthcare aside from the one mentioned in the table above. Please mention the level of impacts as at now or in the expected future.

7. Finnish healthcare and health technology have been regarded among the best in the world. How would you as person, in the industry, describe big-data analytics as a contributing factor, if there is any

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

Back Next

8a. Can you itemize factors you considered as barriers/delay to the actualization full success of big-data analytics/Technology in Finnish healthcare against the expectation

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

8b. Can you please explain one or more of the factors itemized above in details

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

9a. What are the applicable solutions to some of these challenges mentioned.

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

Record ▶ Play 0:00 / 5:00

You can write instead of speaking if you like

10. Thank you for taking the time to participate in this interview! Your contribution is very important to understanding the the role and impact of big data in Finnish healthcare.

Record ▶ Play 0:00 / 5:00

If you have comments, please use this voice prompt or the space provided above:

Submit

Back

Appendix D
Data analytical page of responses