Digital Devices and Data Analysis for Elderly Care

A Case Study

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2015

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Abstract

Title: Digital Devices and Data Analysis for Elderly care: A case study

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Background: Digital devices have become part of the society and have changed the world. Due to these devices, large amounts of data have become available. These data with the right tools can be analyzed to provide vital information about a person's health. Since the global health has increased, the number of people today aged 60 and over has doubled since 1980. The digital devices and data analysis will be of great importance for health care to meet future demands.

Aim: The thesis aims to explore how data from digital devices can be extracted and used to improve a specific modern nursing home in Sweden.

Methodology: A case study was conducted and interviews with five hand-picked respondents were made. With the help of the template analysis, the gathered material was structured and analyzed. To validate the findings a minor field study at a nursing home was made. The nursing home was chosen due to its high-technological nature and its salutogenic approach.

Results: Sensors and portable devices have become important means within the elderly care to measure and gain more knowledge of the elderly's health status. With the help of new technologies, more information can be harnessed than ever before. The belief in data to drive a better health care is good, however, it is important to use the data as a foundation to discuss around and not as the only truth.

Conclusions: This thesis findings conclude the importance of a strategy when analyzing data. Furthermore, the world is complex and new methods that go beyond the standards of today are needed to analyze it. As huge companies spend time and money on integrating data as a part of the analysis process organization such as nursing homes need to consider both the technological side and the empathy based side of nursing in the future as the two are merging. The need for skilled and more professionals within the elderly care will become more evident in the future.

Keywords: Elderly care, Health care, Digital health, Internet of things, Data analysis, big data
### Definition of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Principal Component Analysis (PCA)</strong></td>
<td>The analysis of variability in a dataset. A universal data mining tool to find patterns and to reduce the number of dimensions in a dataset.</td>
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<tr>
<td>B.I.</td>
<td>Business Intelligence</td>
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<tr>
<td>Digital Device</td>
<td>An electronic device that can receive, process and send data depending what operation is needed.</td>
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<tr>
<td>Access Point name (APN)</td>
<td>The gateway between a mobile network (such as 3G or 4G) and another computer network.</td>
</tr>
<tr>
<td>Key Performance Indicator (KPI)</td>
<td>A measurable value that shows how good a company or industry performs in relation to its strategic or operational goal(s).</td>
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<tr>
<td>eHealth</td>
<td>Health care supported by electronic processes or communication.</td>
</tr>
<tr>
<td>mHealth</td>
<td>Mobile Health</td>
</tr>
<tr>
<td>Decision Support System (DSS)</td>
<td>A system to support active decision making</td>
</tr>
<tr>
<td>Data analysis</td>
<td>A process of transformation, modeling, investigation and cleaning with goal to extract information.</td>
</tr>
<tr>
<td>Themes</td>
<td>In template analysis; features of respondents stories characterizing particular perceptions and/or experiences that is found relevant to the research question.</td>
</tr>
<tr>
<td>Coding</td>
<td>In template analysis; a process of identifying themes and attaching labels (codes).</td>
</tr>
<tr>
<td>Salutogenisis</td>
<td>In this context it means that all activities focus on health. Salus; the name of the goddess of health and well-being in the Roman mythology.</td>
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1. Introduction

Digital devices have made a significant impact in health care which has led to a major transition. The health of human beings will always be considered a priority and the use of technology to improve the health care has become evident. With today's technology there are opportunities to digitize the human in a clear way that for many was not possible a couple of years ago (Topol 2012). Digital devices have become part of the society and have changed the world. For instance, a smartphone - a technology gadget which has several devices packed into one hardware. Besides from telecommunication a smartphone may have a camera, a calculator, web surf and other applications to measure and keep track of heart rate, pulse and sleeping patterns. With all the applications available today, there seems to be no limit to what you can do with your smartphone in the future. Cisco Systems Inc., a leading company within communication predicts that the number of connected devices to the internet will be more than 50 billion by the year 2020 (Evans, 2011). Even though the sky seems to be the limit the health care sectors suffers from a paradox (Ekholm & Markovic, 2014) where on one hand it is considered as sophisticated technology to handle (e.g. magnetic resonance imaging), but on the other hand, there is not enough sophisticated technology to handle information regarding daily routines as this kind of software. Some of the software has grown old and is in many cases not appreciated by the end users.

Devices such as smartphones generate a large amount of data (big data). With the right tools, this data can be analyzed and provide a clear picture of a person's health (heart rate, blood values and pulse). The current alteration of health and the health care using technological means becomes more natural and the data to be considered in the obvious future. These technological gadgets are used as support within many areas where time, money and service are crucial parts to achieve good results, especially within the health care sector.

Eric Topol (2012), one of the top ten most cited researchers in medicine asserts the following “We need a jailbreak. We live in a time of economic crisis because of the relentless and exponentially escalating cost of health care, after all we've done virtually nothing to embrace or leverage phenomenal progress of the digital era. That is about to change. Medicine is about to go through its biggest shakeup in history.” (p.VI) All in all, this quotation sums up that the health care needs to keep up with the rest of the digital transformation; a paradigm shift is needed, just like in any other area of society. The technology has come far, and today an information system can be used as a fully functional complement or in some cases even make a better diagnosis than what a human may be able to do (Regeringskansliet 2010). The foundation for this change has already been built and now the actual transition needs to be made.
1.1 Problem discussion

According to a white paper written by Dave Evans (2011) devices are not only related to tablets, smartphones and computers, but also bracelets, clothes, beds and white goods. Today, about 80% have access to a mobile signal (Topol 2012). Due to technology has become more accessible than before, it will lead to a new transition in health care. There have been multiple industries in history that have endured a paradigm shift. One of them is the music industry where the transition from physical media to digital has been a great leap forward in terms of progress and a huge transformation. Likewise, what happened in the music industry same paradigm shift is taking place in health care. Digital devices increases with each day that can help caregivers, nurses and physicians in their work. The products induce a huge readjustment within the health and the health care.

In Europe and the richer countries of the world, three major barriers to innovation within the sector are The policies, The know-how and The prioritization (World Health Organization, 2011). Management does not see the importance of a good infrastructure for decision-making, but rather look at it as anything that the IT-department will or should handle (Ekholm & Marcovic, 2014).

The health care is currently in a phase where it leaves a disease-centered model to put more emphasize on a patient-centered model. According to Nitesh et al (2013) a disease-centered model implies that the doctor or any other personnel with a medical know-how, holds the responsibility for the patient and is the one that makes all the decisions based on tests and medical data. With a patient-centered model, the care recipient participates actively in his or her own care and receives service adapted to their personal need. The approach has been told to be preventive, e.g. with the help of advanced analytics of collected data, possibilities to stop diseases can be reduced in time. This all means that the patient acts preventive to lower the risk of future diseases or any other injuries. The main reason for making this achievable is the combination of technological devices and data with possibilities to extract valuable information.

Stanford Medicine (2014) states in a press release that these technological gadgets show an involvement and that we are about to enter a new era of digital health. Scientists have developed cheap adapters that can be mounted on a smartphone and with the help of the camera will provide high resolution pictures on and within the eye. These adapters make it possible for any ordinary person, despite their education (or lack of education) to share with nurses and caregivers for them to make an assessment and come up with a diagnosis. As a result of this study, the technologies could help the elderly that often lack the mobility and strength. Besides adapters, wireless sensors and wearables has become a broad term in digital health.

Due to extracted data, each device can be used preventively in order to anticipate accidents before they happen or detect early symptoms and adverse changes of the elderly health status. Furthermore, Eric Topol (2012) states that 40 percent of everyone over 80 years falls at least once a year. There are several products out there to predict these cases, accidents (shoes) that
uses sensors to detect unsteadiness when walking. These sensors can warn whoever goes or automatically sends an alarm during a fall.

The World Health Organization (2014) predicts that:
- The number of people today aged 60 and over has doubled since 1980.
- The number of people aged 80 years will almost quadruple to 395 million between now and 2050.
- The number of adults aged 65 and over will outnumber children under the age of 5 within the next five years.

Additionally, the number of older adults will exceed the children under the age of 14. This implies that there will be older people than younger and help is needed for them to take care of the elder. Most of the older people today live in low- each middle-income countries and the number will reach over 80% in the year 2050. Since global health has increased over the years, society must use digital devices in the elderly care to meet any future demands.

The same trend can be seen even in Sweden, where a 60 percent increase in the next two decades for people over 80. Sweden is currently spending about 8 billion (SEK) a year on technology related to public health (Ekholm & Markovic, 2014), where elderly care is a part of that reason mentioned earlier, is about to grow. In a famous Swedish medical journal Läkartidningen an article by Bågenholm (2013) states, in order to meet future demands elderly care must begin with the elder as an individual with their own resources and abilities and move towards a person-centered care. In addition to this, Edberg & Bravell (2013) claims Sweden has not had enough resources to give high quality health care for the elderly population. This study has focused on a company in Gothenburg, Sweden, where much data is being stored as they have embraced new technology such as digital devices. This essay will explore how they can better use their data from these devices to meet future demands in the elderly care.

1.2 Aim
The primary goal of this paper was to explore how a nursing home can extract data from digital devices to improve the care and the services. Also, the purpose of this study was to investigate how a nursing home can use data analysis to make good decisions.

1.3 Research questions
- How can different tools be used at a nursing home to make better use of their collected data?
- Why is analysis of data important to a nursing home?

1.4 The choice of the topic
The topic digital health was chosen for a number of reasons, but foremost because we think that this is more than a buzzword. Our belief is that digital health will grow to become a part of our daily routine. Additionally, we would like to raise awareness about the current topic as the paradigm shift will change the future health care. Finally, we would like to know how to use generated data from digital devices in an effective way.
1.5 Delimitations

This essay focuses on a specific Swedish company that consists of three foundations working in elderly care. Also the study has chosen a few hand-picked respondents within different work field. Due to the technical embracement made by the nursing home, the results from the study cannot be used as a general standard as the result is specific only for this nursing home.
2. Theory

Today's technology would not have been possible were it not for the various major advances in history. For instance, the first cell phone was invented by Marty Cooper in 1973 (Encyclopedia 2015) and shortly after the personal computer (PC) by Michael Wise was completed 1975 and a significant impact when ARPANET and Nnet merged and become today's internet in the year 1990. Finally, in the early 00's came several devices on the market such as the iPod in 2001, Blackberry 2002 and iPhone 2007. Altogether, these different technologies have made advances that have been an extensive impact how society looks today.

As a result of the increased number of devices today in many different areas and shapes, they all have a common concept, "Internet of Things" (also referred to as IoT). The number of devices per capita was until the release of the Apple iPhone in 2007 below 1.0 (the entire world population). After Apple’s release, the number of devices per person grew exponentially and in 2010 the number of internet connected devices, such as tablets or mobile phones had reached 1.84 billion. Cisco (Evans, 2011) defines Internet of Things as the point of time when the number of connected devices will outnumber the people walking the earth. Using Moore's Law, Internet of Things was born somewhere between 2008 and 2010. By definition, the Internet of Things era is already here.

Earlier in history, data were typed by employees, however when the internet arrived the data collection evolved to include users and today the data collection also includes machines. Another essential point, is that the machines have outnumbered the people and the amount of data has grown tremendously. Despite the fact that Big Data has achieved great rhetorical power, it still lacks a widely accepted definition (Vienna et al. 2015). Nevertheless, in this study of literature searches have revealed that Gartner’s definition is widely used among big data definitions. The Gartner definition reads, “Big data is high-volume, -velocity and -variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making”. However, more recently, Bernard Marr (2015) describes big data as four elements; volume, velocity, variety and veracity. In reflection, big data effects nearly all businesses today and the health care, will be the next one to embrace the data and how to use it. Historically, health care has been a place for curing diseases and other health related symptoms at the hospital. Hence, with possibilities to extract information from large amount of data could open up new opportunities. As a result, this enables health care to work preventive and prepare with the right resources to cure people in time. To make this possible, it’s necessary to implement the digital infrastructure for health care to meet future demands of health care.

Connected health has been mentioned as an umbrella description that covers digital health, eHealth, mHealth, telecare and telemedicine (ECHAlliance, 2014). According to Connected health white paper (2014) there are no legal or commonly accepted definitions. Wragge & Co (2014) argues that a reason for this could be that there are no global technical standards in terms of equipment and data, nor any legal regulations. According to the European Commission (2008) a regulation of the eHealth market is needed to move forward. Despite this, several of the definitions exist which are helpful to get a glance what the different terms mean. For instance, the digital health definition by Paul Sonnier (201) use a holistic view. He states “Digital health is the convergence of the digital revolution with health, writ large. In addition to medicine and health care, digital health encompasses
consumer-focused sports, fitness and wellness solutions, which can be considered preventive medicine” (Paul Sonnier, 2015, LinkedIn). Next, Eric Topol (2012) describes Digital health as eight super-convergence elements.

2.1 Earlier studies of data analysis and digital devices

At the dawn of the IoT era, ZigBee Alliance released a new standard protocol (ZigBee) to transfer data with low power consumption to a low cost. ZigBee came as a toolbox; for the health care an ECG (Electrocardiograph) monitor that was attached to the chest and a platform. The first study to use the ZigBee protocol to transfer data from a glucometer and an ECG to a web server by a group of scientists in 2006 and was carried out on a mixed gender group with the average age of 70 years. They were divided into two subgroups, the first group with 9 people went through the ECG and the other group of 20 people, had the Glucose level monitored (Hak Jong et al. 2008). The device collected data on an hourly basis, however, if the patient felt palpitations, he or she was asked to manually push a button for the device to collect data.

The data was transmitted from the device to the web server via a mobile phone or through an IP-transmitter. The study was not considered to be successful from a technical point of view. The reason was because the data loss in the glucose group reached 22% and where the majority of the root caused was unidentifiable or unable to trace. Hence, the research group came to the conclusion that the communication between the sensors and the mobile phones ought to be the major reason for failure. Due to the major data loss, only a small part of the data collected could be used, something that resulted in poor medical results even though the focus point of this study was the technical impact rather than clinical (Ibid. 2008).

The patient satisfaction for the glucometer was better than for the ECG. The only criticism from the Glucometer group was that the lifespan of the batteries - this was about four weeks. The score from the ECG group was affected by poor battery capacity (one day) as well as the
skin irritation problem (Ibid. 2008). A group of researchers (Kim, H-S et al. 2014) released a paper in 2014 with the purpose to explore the use of mobile phones within health care management. Mobile phones are common, but because elderly people may be unfamiliar with mobile devices, the system needs to be easy and user friendly. From a technical perspective, cellular-phone-based medical informatics (CPBMI) that is a part of the paradigm shift within modern health care combines IT with medical care.

Data from biosensors (e.g. bracelets to measure ECG, Glucose and heart rate) and environmental sensors (such as beds) are gathered into one place (the phone) where the data is displayed. It is important that the mobile phone has large icons, colors that can be distinguished easily and a clear font that is easy to read. The concatenated data is sent to a medical team (nurses, nutritionists, physicians) who provides individual feedback which is an important part of CPBMI.

Another essential point is a study done by Miskelly (2001) that presents different assistive technologies such as health monitor, fall detectors and video monitoring. The most interesting according to this study is the health monitoring part of the study. The study used a sensor device with the same size as a watch that was worn on the wrist. This device collects data over a period of time, which develops a pattern. Based on these patterns data is analyzed and creates a profile of activities the user has. Furthermore, the device is designed to detect collapses, faints, blackouts or other similar events. Additionally, the device can also be used as a wandering detection system (if the user get out of range it will trigger the alarm) or monitor the person's wellbeing. Although this study is relatively old this study shows that even before IoT, technology to conduct the study was already present.

Khawandi et al. (2010) argues that a better way to collect information about a person is through video monitoring. They created a system to detect if a person had suffered from a fall through collection of data via webcams that were placed in the patient's home. Face recognition was being used to collect information such as facial color, position, and distance to the webcam. The images recorded by the webcam were processed and analyzed to determine if the person had suffered from a fall. The advantage with this method is that no devices need to be attached to the patient's body. The images could also be used to go back and actually see what really happened, something that is impossible with just raw data.

DiCarlo et al (2012) had a closer look at systems and methods to assess medication taking. The most reliable method is DOT (Directly Observed Therapy) where a clinician is observing and documenting the time and date of the patient swallowing each dose of the medication, a method that tends to be resource intensive and time consuming. Other methods include:

- Video recording
- Patient questioning
- Patient pill diaries
- Daily pill count or weight of containers
- Prescription refill rates

All methods mentioned in the list above shows if a container has been opened, but none of them are reliable in the sense that they actually show that the medication has been ingested.
The group of researchers had a look at a system where the pill was statistically counted for once it reached the stomach of the patient and not until then.

Ingestible sensors (Ingestible Event Markers, IEM) and an adhesive external monitor (Protheus Personal Monitor, PPM) were being used. The IEM which is safe to ingest and as big as a grain of sand, is placed on the pill. Once the pill reaches the stomach, the IEM and the stomach fluids reacts and creates a signal that can be detected for about 10 minutes. During these 10 minutes, the PPM that needs to be attached to the skin in order to work register the time and date.

The PPM has also collected biometric related information such as heart rate, activity, sleep and sleep quality to its flash memory. The encrypted data in the flash memory is transferred to the patient phone through Bluetooth where the data can be passed on further to a secured web server. Based on earlier studies, at least 278 ingestions needed to be made (6 per day by ten healthy males) in order to achieve scientific relevance. As a benchmark, the study was filmed in the Positive detection accuracy (PDA) was good. With a 99.3% match to the video recordings, both the Ingestible Event Marker (IEM) and Protheus Personal monitor (PPM) have been CE-marked with FDA clearance in the United States of America (Ibid. 2012).

Complementary to this, a lot of user data is collected from multiple sources today. Data that is not intended for research purposes first hand but collected for operational reasons. Companies spend a great amount of time and money to improve the efficiency of their online and mobile advertising, which is what the mobile channel and the internet is primarily used for from a business model perspective.

This strive for optimization led to technological advancements in areas such as databases, data mining and machine learning. The huge amount of data has created a “Big Data” era, where Grossglauser & Saner (2014) identify three major trends. The first trend concerns uncertainty of data. With traditional statistical analysis the focus lies in extracting as much of the basic information as possible, out of a limited amount of data. With the now available massive data sets, data mining and machine learning can be used to discover more complex patterns. The second trend concerns scale. The explosion of data volumes created and available over the last decades has created new possibilities. The third trend is energy. With an increasing amount of computing power and with storage that still becomes cheaper, much of the energy is required to support this kind of infrastructure.

The trends are all relevant for the medical community but even if there is immense data that can be harnessed, the data is often unstructured. This calls for new methods such as:

1. **Individual patients monitoring and analytics**: The use of data from multiple sensors can improve the quality of health care to a lower cost. For instance, the system mentioned in Chih Ming Chen’s (2010) article “Web based remote human pulse monitoring system with intelligent data analysis for home health care”.

The system collected data from sensors and data was being stored for further and deeper analysis some data such as the heart rate and the pulse of the person was displayed through a web interface where the patient can monitor how she or he was doing. The information could be used for home health care or used for a doctor remotely.
2. **Communities of patients, networking and sharing:** People can influence each other through different social networks. There has grown to become quite some search services on the internet where an individual can search for information about different symptoms. The data concerning what has been searched for can now be extracted and with pattern recognition and further analysis unexpected patterns can be found.

3. **Society as whole managing epidemics:** With the help of the mobile phone epidemics can be prevented by avoiding person to person contacts. The phone works as a two-way communication device that collects behavioral fingerprints and can give real time recommendation to users. With the collection of e.g. the geo location the phone can send you a warning if you are getting close to an epidemic area and propose an alternative route.

Additionally, a study done by Graber and Mathew (2007) presents web-based clinical decision support system (CDSS) called Isabel. The system data store includes 6 key books in medicine and 46 major journals. The system search box accepts key findings or free text entry (see figure 2). The physician enters the key findings from the patient in the search box. Then the results are filtered to take into account of age, geographic location and other parameters. The average time for entering data to receive results was less than 1 min. To illustrate how the system works, the study tested 50 cases with the knowledge of the patient's final diagnosis. The patient's history (physical examination, findings and laboratory results) were entered into an Isabel’s data entry. The result from study shows that 95% accuracy of all diagnoses at emergency room versus physician that only have 35% accuracy diagnosis.

![Isabel's data-entry screen](image)

**Figure 2:** Isabel’s data-entry screen (Graber and Mathew, 2007).
2.2 Data analytics tools

Data is the establishment of instructions, facts, information or concepts in a disorganized form (random numbers, words and symbols). Data can be virtually anything in our universe, which is then processed by humans or systems (Bennett, McRobb and Farmer, 2010). Due to increasingly more digital devices today generating large amounts of data to store in places such as warehouses and clouds, it has become crucial to meet future demands. More importantly it is how to use all the data efficiently. According to Bernard Marr (2015) less than 10 % of all data is vital in an organization. In short, this means that the quality is more important than the quantity of data gathered. Complementary to this, a study by International Data Corporation (2013) found that only 22% of the information in the digital universe was candidate for analysis and only 5 % was actually analyzed. Hence, different tools and processes such as data mining exist; a usual analysis process to see patterns and relationships that create a solid foundation to make good decisions within an organization. For instance, Jawbone (a wearable device) can use their data to learn more about sleeping pattern such as how sleeping affects us while traveling. Also, the famous computer Watson by IBM has made a partnership with Apple to deliver data and analytical tools to health care organizations (IDG 2015).

2.2.1 Data mining

There are several definitions of data mining, according to Simoudis (1996) “ The process of extracting valid, previously unknown, comprehensible, and actionable information from large databases and using it to make crucial business decisions.” and more recently Han et al (2012) states that data mining is a process to discover patterns and knowledge from large amounts of data. Connolly & Begg (2010) states there are four main operations in data mining, which are predictive modeling, database segmentation, and link analysis and deviation detection. Depending what demand at hand, these operations have different techniques such as classification, statistics or demographic clustering. First, predictive modeling, is an statistical data model that shows patterns of future behavior such as risk models for future crimes. Second, database segmentation, a database is partitioned to unknown segments which creates a homogeneous result. Thirdly, link analysis that uses different associations (links) in the database to find patterns. Finally, deviation detection technique that identifies outliers which shows previously expectations and the norms.

2.2.2 The SMART framework

Bernard Marr (2015) discusses that instead of starting with data, more importantly start with the business objectives and find out what it is that needs to be achieved. He discusses, to be successful and competitive in the future an organization must use a SMART plan as can be seen in figure 1. Based on his ideas, before analyzing any data, an organization must establish what they really want to know, why it is important and to ask questions that needs answers to. When the strategy is in place the organization has to measure metrics in other words check what type of data are necessary to answer previously asked questions. Next, in order to extract meaningful and useful businesses insights, an organization has to analyze the data. Hence, business data exist in five different formats - text, sound, image, video and sensor. Depending which type of format you are looking at, it is essential to take into account before applying data analytics. Hence, by dividing your data makes it better understand and identify patterns of behavior. Furthermore, results should be displayed in such a way that is makes it easy to understand which is completed with different visualization and management tools. Finally,
based on organizations results, they can move towards a more fact based decision making and gain competitive advantage.

Figure 3: SMART model by Marr (2015).
2.2.3 The SEMMA methodology

On the contrary, instead of look at data mining as a set of tools it can be viewed as a process. SAS Institute Inc. (1998) demonstrates an iterative cycle process that divides data mining into five stages (see figure 4). The sum of these stages forms an acronym SEMMA which stands for:

- **Sample** the data by creating one or more data. The samples should be big enough to contain the significant information, yet small enough to process quickly.
- **Explore** the data by searching for anticipated relationships, unanticipated trends, and anomalies in order to gain understanding and ideas.
- **Modify** the data by creating, selecting, and transforming the variables to focus the model selection process.
- **Model** the data by allowing the software to search automatically for a combination of data that reliably predicts a desired outcome.
- **Assess** the data by evaluating the usefulness and reliability of the findings from the data mining process (SAS Institute Inc., 1998 p.3).

![Figure 4: SEMMA methodology by SAS Institute Inc. (1998).](image)
2.2.4 Multivariate Data analysis (MVDA)

Multivariate data analysis is used to investigate multiple variables simultaneously. The technique lets you understand the possible relationships between them. It does not matter if the matrix has two variables or millions of them the analysis does not get more complicated with more variables. MVDA looks at the variables that affect the data the variability in the data set mostly and then isolate the ones that relates to each other.

Multivariate data analysis is represented in a graphical way which makes it easy to get a quick insight from millions of rows of numbers. (Swarbrick & Camo Software, 2012)

![Figure 2: A graphic presentation of Simca by Umetrics (2015).](image)

2.2.5 Social Physics

Social Physics is a quantitative social science. The science is new, but has its roots in the sciences from the 1800s. It describes reliable and mathematical connections between information, the idea flow and also people’s behavior. With the understanding of how ideas are spread from person to person through social learning, we can get a better understanding of fundamental things that affects a society such as productivity and creativity. The engine behind Social physics is Big Data. Social physics analyzes patterns of human experience and idea exchange within the digital breadcrumbs that are left behind every one of us in a modern society.

In a keynote speech from mars 31st 2009, the European consumer commissioner Meglena Kuneva (2009) mentioned that:

“Personal data is the new oil of the internet and the new currency of the digital world.”

A successful data-driven society must be able to guarantee that our data will not be abused by anyone. The detailed nature of these digital breadcrumbs makes it possible to use it for both
good and evil. It has e.g. as earlier mentioned, been shown that the use of such data has helped to diminish the outbreak of a flu epidemic. Alex Pentland proposed a framework around “a new deal on data” in the World economic forum (2007) and he believed that the seed planted then later, through many discussions helped form the Personal data protection in the EU that is

“..Intended to accomplish the combined trick of breaking data out of the silos they’re currently held in, thus enabling public goods, while at the same time giving individuals greater control over data about themselves.” (Portland, 2014 pp. 101)

In Sweden we have the Personal data act (PUL) based on directive 95/46/EC which aims to prevent the violation of personal integrity in the processing of personal data (datainspektionen, 2015). Portland (2014) argues that the World Wide Web has evolved with no coherent privacy standards about personal data while industries such as medicine and finance have heavy regulations with a relatively clear ownership rules. This will probably change and companies such as Google, have already started this journey by being a part of the world economic forum, and on a personal level the creation of their dashboard where you can see their information collected about you. Pentland emphasizes that the biggest barrier to building better social systems using Big Data is not the size nor speed. Not even the privacy and accountability in sharing the data.

“The biggest challenge is learning how to build social institutions based on the analysis of billions of individual connections. We need social physics so that we can move from systems based on averages and stereotypes to ones based on analysis of individual interactions.” (Portland, 2014 pp. 102)

As an example, Pentland and his research team have created a web tool based on Google maps that shows the poverty, crime rate, change in GDP and other social indicators updated daily. It is updated by a neighborhood basis and with these maps you can track where e.g. new governmental initiatives are working and where they are not (Smith, C et al. 2013).

With new techniques and by working with unstructured data the need to be more careful is more evident than ever before. New quantitative, well proven theories need to take shape in order to make the most use of the new data that we now can access. Pentland (2014) also argues that we need to go from a laboratory environment to the real testing environment (referred to as a living lab) earlier as much of the data concerns human behavior.
2.3 Theoretical Concepts

The theory presented earlier in this chapter has shown the following theoretical concepts. These concepts will be used to confirm this thesis findings in analysis chapter. The list below will provide a summary of each concept.

1. Data analysis combined with Electrocardiograph (heart rate) monitoring could be used in a nursing home. (Hak Jong et al., 2008)
2. Sensors can improve the quality and health care in a nursing home (Grossglauser and Saner, 2014)
3. The SMART concept as a data analytics methodology in a nursing home. (Marr, 2015)
4. Multivariate data analysis as a data analytics tool in a nursing home. (Swarbrick & Camo Software 2012).
5. Data analysis with digital devices (video monitoring) can automatically trigger an alarm to call for help. (Khawandi et al., 2010),
6. Data analysis from collecting data with ingestible sensors and personal monitor can be helpful for elderly. (DiCarlo et al., 2012)
7. Use data mining as a tool for extracting valuable data in a nursing home. (Connolly & Begg, 2010)
8. The nursing home can use clinical decision support system (CDSS) to help speed up health care process. (Graber and Mathew, 2007)
9. The SEMMA methodology could be used to extract information from big data at a nursing home. (Obenshain, 2004)
10. Social Physics as a new way of analyzing behaviour and the spread of ideas (Pentland, 2014)
11. Health monitor device with size as a wrist watch can with conjunction of data analysis be used at a nursing home to detect person's well-being and detect events (such as falls, collapses) that trigger alarm. (Frank G. Miskelly, 2001)
3. Research Methodology

The basic intent of this chapter provides an overview of the thesis methodology. After examining the research questions a qualitative study was better appropriated, rather than a quantitative. Therefore, the interviews are the foundation, due to its effectiveness in generating valuable source of data. As the study has limited the number of respondents to a few hand-picked (see chapter 1.5 Delimitations), the case study had no interview guide to be applicable for all of our respondents. Since each respondent has a different background and a different part to contribute with in this essay. Consequently, the research was done with altered semi-structured interview guide for each occasion.

The qualitative nature of interviews generated plenty of unstructured information. In order to manage the amount of data collected, there will need to be structure. By using template analysis, which is a method to structure the collected information into different themes for further analysis. The method was chosen for this study, hence it was easy to understand and follow with a clear deliverable; a template that could be used and followed to do the actual analysis. This is also an excellent tool to increase the information credibility.

As shown in Figure 5, the study used a qualitative approach. A problem was defined and through research, enough knowledge was acquired to build a relevant theoretical framework. A few hand-picked respondents were chosen and interviewed. The interviews were recorded and with the help of Template analysis, the texts could be structured and divided into different themes for further analysis and comparison with the theory. From this, conclusions could be drawn and a discussion could be put on paper.

3.1 Research design and strategy

According to Bryman and Bell (2011) it is important to consider how concretely to perform and analyze the data, which can lead up to the selection of research design. In research there are “five different research design approaches experimental design, cross-sectional design, longitudinal design case study design, comparative design”. (Bryman and Bell, 2011 p. 67). This thesis used a case study design based on a deductive approach. John Creswell states “A case study is a good approach when the inquirer has clearly identifiable cases with boundaries and seeks to provide an in-depth understanding of the cases or a comparison of
several cases.” (Creswell, 2007 p.74). Therefore, this paper used one case study as a research method to obtain a deeper understanding how data can improve health care. Equally important, is the location on which the study was conducted provided important source of information. Next, the research used multiple sources of information such as interviews which contributed valuable data for this study.

Additionally, the study was divided into two parts. The first part was a literature study and will describe the challenges within health care and how technical aid can help in general. In the second part, the case study was conducted at a nursing home, which was examined through interviews. Furthermore, a research need a strategy which consists of two different approaches, quantitative and qualitative research. Due to the problem discussed earlier, that requires a detailed understanding to comprehend the problem of this study, a prerequisite for people of knowledge in this area is needed in order to extract the valuable information from the interviews. A book by Creswell (2007) a “Qualitative research begins with assumptions, a worldview, the possible use of a theoretical lens, and the study of research problems inquiring into the meaning individuals or groups ascribe to a social or human problem.” (Creswell, 2007 p.37). As a result of this study's research questions gave a further conviction of choice for case study. As explained by Yin (1994) a case study has distinct benefits when “’how” or ”why” question is being asked about a contemporary set of events over which the investigator has little or no control”. This concludes qualitative strategy with a case study design.
3.2 Case studies

A case study implies focus on a smaller delimited group. A case can be an individual, a group of individuals, an organization or a situation. This is a holistic approach and more than one case can be studied (Patel & Davidson, 2003). Case studies can be distinguished from other approaches such as surveys by research through “interpretation in context” (Cronbach 1975, p. 123). The approach is descriptive and heuristic as insights about the particular phenomenon that was examined. Moreover, as a method of research it is more useful, adaptable, and possible to develop than other methodologies in a given situation (Patel & Davidson, 2003).

3.2.1 Data collection

The primary source of information for the thesis work will be semi-structured (qualitative) interviews as part of the case study. Based on the literature study that was done in chapter 2 people of interest were contacted and asked for an interview session.

3.2.2 Tableau and SMART

The structured data that we gained access to was not a part of the case study itself. It was merely used for us to learn how different tools could be used to work with the data and to gain deeper knowledge about frameworks and the tools and methods that we came across during the literature study. The SMART (2015) framework was used with the data from the company’s emergency alarm system together with a software called Tableau (2015) to visualize the data for a clear view over the triggered alarms (see appendix A and B). Other tools could be used but a decision to use the SMART and Tableau in this particular case was taken. The use of SMART and Tableau was not a part of the research methodology - the template analysis, however this worked with our research.

3.2.3 Interviews

Interviews may be the most common used method due to its flexible nature (Bryman & Bell, 2011). The data can be collected in both quantitative and qualitative formats where quantitative involves data that is structured or numerical while quantity is the collection of non-numeric data (Marr, 2015).

The interview was usually conducted face to face or via phone. The flexibility was not only done with the possibility to add or re-order questions based on the answers in a semi-structured interview but also in terms of technology. In some cases the interviewee refuses to be recorded and in some the talk continue after the recording was stopped. A talk revealed important information to the interviewer. In these cases the interviewer needs to put notes on a paper as well (Bryman & Bell, 2011).

3.3 The Interview Questions

The key aspect discussed about more digital devices becomes evident in this study approach. In conclusion, this may lead to increased data quantity for all sectors in health care and nursing homes. Digital devices are in the breach to be an important tool in health care. This has led to companies developing devices for nurses and other caregivers to use in health care. For instance Ascom (2015) has released a phone called Mycom adapted to the health care
environment. To sum up, the interview questions are based on the theory in the previous chapters.

As it has been presented previously in this chapter, earlier studies with different digital tools has proven to be helpful in health care. For instance, Grossglauser and Saner (2014) states that with the devices that exist today, health care can harness data in order to get feedback and recommendations for patients. Likewise, Chen (2010) has found that web-based monitoring system has the potential to increase home health care (which often applies to elderly care). Respondents in this case study are chosen based on their work and experience, hence, this allowed the researchers to get a holistic approach on how to embrace the data analytics for a nursing home. Additionally, the thesis respondents can contribute with different information such as what type of strategic questions should be asked within organization relative to the SMART model (Marr, 2015).

Before a scheduled interview, questions were written based on an interview guide according to Bryman et al (2011). This interview guide was explained and illustrated according to figure 6. Also, it can be found in appendix A. Furthermore, for each of the interview a brainstorming and a question based theory was conducted for qualifying questions to the respondent. Next, the answers from respondents would in some cases give additional questions which can result with an extended theory. Then, in some interviews after answers were sorted it may result in further additional questions that extended the theory even further. Finally, analysis and result are presented.

![Figure 6: Overview of the interview schema.](image)
3.3.2 Respondents and interviews
The interviews were limited to one hour where the authors met up with the interviewee. All meetings were audio recorded with the consent of the interviewee and then transcribed for further analysis. In the cases where the interview was being held in another language than English a translation was made by the authors during the transcription process. This means that some linguistic shades might have gone, lost in translation as English is not the author's native language.

There were in total five respondents, all chosen due to their field of expertise of either analytics or the company examined and participated voluntarily. They were all given pseudonyms and the names of the companies that they worked for were left out on purpose unless they asked otherwise.

3.3.3 Sampling
Due to respondents different work field and background, the case study is based on convenience sampling. Which means the selected respondents were chosen based on the variety of work, experience and age. The variation among respondents were better contributing to this thesis conducted interviews.

3.4 Data analysis
In qualitative studies there exist several different tools to manage the volume of text in an effective way produced by interviewees. Hence, qualitative studies are not quantifiable, which require more time and resources to analyze the produced text. The most common tool within qualitative studies according to Bryman et al (2011) is thematic analysis. Thus, this thesis used another structured technique called template analysis developed by King (2015). According to King the template analysis differs from another common method, the framework analysis. In Template analysis, the priori themes and codes are dynamic and can be revised during each iteration. In a Framework analysis, the framework is set from the beginning unless something extreme comes up the themes are intact.

3.4.1 Template Analysis as a method
The method starts out with the researcher defining priori themes for the analysis. In this very first part the goals were set and the interviews (any type of qualitative data) could be transcribed and read through for a better common understanding. In the next step a text was analyzed and matched against the different priori themes that were set up in the first step (coding). If there is no relevant code for a transcribed section, the code needs to be redefined or a new one needs to be created. This part is called the initial coding, an iterative process where you hold the actual template next to the transcript while going through it.

After the coding it is time to create an initial template. It is not compulsory to finish the initial coding of all transcripts to start this step, but a researcher needs to keep in mind that there is a danger of producing it too early, as it might interfere with the attempts to approach a fresh transcript with an open mind. As a rule of thumb, the point of time where an initial template should be created is when the preliminary coding does no longer create any new themes different from those already identified. The comprehensiveness of the initial template varies but it is important to cover the thematic areas without being too concerned with the
details. Putting too much time on the details and the initial template may lead to unwillingness to make changes later in the process.

When the initial template is created it needs to be developed to such an extent that it represents the data through the themes in a good and understandable way. The development is an iterative process where the template is being tested against each transcript. In this process any four changes are made:

1. **A new theme is added**: if you find an issue in the text relevant to the research question not covered by the existing coding you need to create a new theme and add a new code.
2. **A theme is being deleted**: You might realize that the material fits better into another code or a priori theme turns out to be unusefull.
3. **The scope of a theme is changed**: if the Scope is too narrow or too broad it might need to be redefined.
4. **The Higher-Order classification of a theme is changed**: An initially classified sub-category might fit better as a sub-category of another higher-order theme.

You need to have a pragmatic approach since there is no stage where you can say with an absolute certainty that the template is finished (King, 2014). When the effort to make another revision is higher than the increase of quality by doing, it is usually time to stop the iterative process.

The template can now be used to interpret and write up findings. Throughout the process it is important to stop and one or more coding stages and carry out a reflexivity and quality check in order to make sure that the system is not affected by your own assumptions and perceptions.

The template itself is not the end product of the analysis but is there to help the researcher to interpret the data. A common mistake among inexperienced qualitative researchers is according to King (Ibid.) to make the assumption that interpretation is the same as summarizing the interview contents indexed under each theme. The transcripts or summaries of the mentioned will be sent to the interviewees for validation in order to make sure that the authors have not affected the result with the authors own assumptions and perceptions before the analysis. Template analysis is a good approach to compare perspectives of the different participant groups about their experience of the context (University of Sheffield, 2014).

In the study a template was developed using the methodology of template analysis. The template held a structure in which the results from the data collection (interviews) was placed. Information from the interviews were added to each code and theme and later rewritten to suit the themes.

### 3.5 Method evaluation

Validity covers to what extent a system of measurement manage to measure what was intended to be measured; the absence of *systematic* errors (Nationalencyklopedin, 2015) while reliability concerns whether the result will be the same if we do the experiment again or if there were any additional *random* or temporary circumstances that led to errors (Bryman & Bell, 2011).
Based on the ideas of King (2014) to increase credibility, the data findings were summarized from each respondent and then were sent back to the person for feedback and additional comments. This was done to avoid misunderstandings and misinterpretations. Due to this the respondents had a chance to correct any mistakes made. In short, it was a great tool to increase the information credibility due to quality checks and reflexivity.

3.5.1 Limitations and the extent of this work

The caretaker was in focus. Furthermore, the report were focusing on the data collection and techniques to perform the analysis. The report will not answer how to use the result from the analysis nor how to implement it. Mathematical theorems were left out.
4. Results

The result of this paper is presented in this chapter. This thesis collected data are presented with different interviewees that have been conducted in this case study. First, a presentation of the interview respondents is made. Additionally, a description of the results from the conducted interviews will be presented.

4.1 Respondents

There have been five interviews in this case study that has been recorded. The interviews range from 20-60 min. To preserve holistic perspective in our study the respondents have different backgrounds and experience in various work areas. Therefore interview questions have been adapted for each respondent as can be seen in appendix A.

**Johan** is the administrative director for the nursing home, Three Foundation. He has a background within the economy and has a great interest in continuous improvements and the use of technology.

**Olof** is an Expert in terms of Multivariate Data Analysis and the statistical software SIMCA. He holds a Ph.D. in chemistry. Olof works as an instructor and consultant to help companies and institutions to look at their data in a logical way.

**Johan F** is a Global Service Technology Manager within the incontinence care. He has a master's degree in business administration and has been working with service development since 2007. Johan is also involved in an innovations team within web service and technology.

**Anders Ekholm** works as Deputy Director at the Department for Future Studies. Prior to his current position he has been working within the government offices in Sweden since 1989, most recently 8 years as head of research for the department of Health and Social Affairs.

**Kajsa** works at the nursing home since 2012 as a care responsible nurse. Prior to this, Kajsa has been working within the acute care and is open to new technologies.
4.2 Collected data from interviews

In order to find out how a nursing home can use their collected data the interviewed respondents were chosen by their area of expertise and background. The following five interviewees were chosen based on their area of expertise. Two of them work at the nursing home but with different working areas.

As presented earlier in this chapter, the thesis uses the template analysis to extract information from the conducted interviews. Hence, this chapter will thoroughly explain the result of this analysis. Furthermore, this chapter presents findings of this study based on the template analysis.

4.2.1 The Case Company

The company related to the thesis is a nursery home foundation named as, Three Foundations providing salutogenic care to about 360 senior citizens and elderly with functional impairment. As the name itself implies, the company refers to three different foundations (Ålderdomshemmet i Göteborg, Göteborgs Sjukhem and Otium) that are being administered as one unit since 1988.

After an initial contact with Johan, the administrative director we found out that the foundation, due to its high-tech nature, have a great number of data but do not really know what to do with it and how to make the best use of it. The current system interfaces are being used to look at the reports that the system provide. Thus, another approach and the proper tools would make it possible to harness more value from the data already collected.

In terms of infrastructure, a Citrix environment has been implemented for the thin clients. Every room and common area has an iPad mounted to the wall where a nurse or assistant nurse can log on with his or her credentials to register that medicine has been given. The system MCSS is significant for the nursing home and was created with a purpose. The system lets a registered nurse sign in to see the elderly’s journal, approve and set how much and when it should be given. He or she can also administer who is eligible to give the medication (e.g. an assistant nurse).

During the short period of time when the thesis was written, Three Foundations, tried new technological aids to help improve the quality of life for the elderly. One of those gadgets was the TENA Identifi solution that would improve the incontinence care and help the elderly to sleep better throughout the night. The home was also looking into smart washing machines to help the staff and to limit the carbon footprint.

4.2.2 The Interview with Olof

Multivariate data analysis (MVDA) is the investigation of many variables, simultaneously, in order to understand the relationships that may exist between them. MVDA can be as simple as analyzing two variables but can also involve up to millions of them. Olof that works as an application specialist and educator for Umetrics was chosen because of his expertise within Multivariate data analysis. Olof has worked for Umetrics for 4 years. He holds a Ph.D. in Surface and Colloidal chemistry and has been working for AstraZeneca prior to his current work.
Most of the clients give Umetrics a dataset in form of an Excel file that they want to have analyzed with the help of Multivariate data analysis. However, data can also be collected through direct connections to databases. MVDA is a technique where you look at all the data at the same time. You do not look at one variable at the time but all of them simultaneously to get the whole picture.

The company uses its own developed software called SIMCA to perform the analysis. There are different MVDA techniques. Principal Component Analysis (PCA) is used to get an overview of the data. It is used to find outliers, trends, similarities and differences within the samples. A PCA extracts the information in the data that contains structure and leave the random variation, noise, out of the data analysis. There are other types of MVDA for example Partial Least Square (PLS) which is used for multivariate predictions. MVDA can also be used for monitoring manufacturing process. A common workflow strategy for process control that is being taught by the company is the following one (Umetrics, slide 36, pp. 114):

1. Define part of process to work with
2. Complete processes or selected
3. Define a “good process”
4. Select relevant variables
5. Raw data analysis and treatment
6. Build a model representing good process behavior
7. Validate the model
8. Real time monitoring
9. Continuous improvements

Multivariate data analysis is not known to everyone and if you only know it by name it might be hard to understand the power of the technique. The technique should be used when the amount of data is so large that it is impossible to get an overview of all the variations in the data set with an univariate data analysis made for example in Excel. Another application of MVDA is quality assurance where all the product quality attributes for the product can be overviewed in one single plot.

4.2.3 The Interview with Johan

Johan is the administrative director of the case company (Tre Stiftelser). His area of responsibility concerns the economy, property, IT, telephony and various other things that might come up and not related to food or operational work (caregiving). Johan was interviewed based on his extensive knowledge about the business. He is also our primary contact at the case company.

The nursing home does not record audio or conversations with the elderly even though conversation is a big part of their work.

The 400 iPads mentioned in chapter 4.2.1 (The case company) are used to sign for medication for each individual and generates approximately 2000 transactions a day (67 000 / month). Information about the time of the event, person of interest, the logged on user and what medication that is stored. If no medication was given at a certain point, the reason for this is also typed into the system.
Every alarm transaction is stored with status information about the trigger, the accept, when the action was closed and taken care of. The number of alarms and response times can be the base for a discussion with employees and relatives as an objective point of view (quantified). The company takes part in and receives the results of nationwide surveys where the respondents are anonymous and the survey is being conducted by a 3rd party. There is ongoing work with the way this data is being collected and the company has looked into models where the resident can participate easily by pressing e.g. symbols.

Three Foundations wish to use more applications in their iPads in the future. iPads have a low user threshold which is very convenient when new or temporary staff start working. There is no need for education to learn how to use this application. iPads are also used in the medication routine. Three Foundations plan to integrate the food ordering process into the system. The nurses are currently writing down which one of the two types of meal the resident wants for dinner or lunch on a list. With the system integration, the amount, cost and recipes can be generated together with labels for each individual for the food provider to print out from a system called Matilda provided by the company Foodit. Moreover, the historical data can be analyzed.

The new Ascom phone called Myco has an app and hardware combined, adapted for healthcare. The device needs to be available and runs on a 14 hour battery. This fits well with the requirements that Three Foundations have put up. The device needs to be a mobile device with DAC, Wi-fi and IP-classification. Furthermore, it should manage to be disinfected and there must be possibilities to change the battery. The TENA Identifi product was under evaluation at the time when the interview took place. Data from the products can be used to track when there is a urine leakage and can be used to prevent this from happening, e.g. by visiting the toilet at a more proper time.

Based on the historical data from iPads, the case company is able to measure or quantify performance among the employees. This is a base for discussion to identify problems and should not be considered a monitoring tool to monitor the employees’ performance. The alarm transactions can be analyzed in different ways. One way to look at the data is by geographical location, where the room or apartment is the smallest unit of measure. Data Mining, is currently not being used and standard reports from existing systems are used. Although Johan believes in analytics, business intelligence applications are not worth dealing with until enough data points or metrics are available to make proper analysis. He believes that it would be interesting to see correlations between e.g. food and health conditions, especially when the resident is in such shape that he or she cannot communicate in an effective way.

Johan finds it important to establish a common view towards technology and what it can do to help employees in their daily work. From an ethical point of view, working with technology, generates a hard but an important task - to create balance between increasing the safety among the residents and the violation of integrity. New roles will probably be created in the future to handle IT and data management so that the nurses can focus on the emotional aspects (nursing).

The company's focus target is to create wellness among all of their residents. In order to do this, they need to find an answer to how this can be achieved. They have an operational plan
that they follow. More data about wellness would be appreciated. Unlike hospitals where the
goal is to make the caretaker leave the hospital this line of business deals with residents that
arrives but never checks out (they are getting worse until they eventually die).

4.2.4 The Interview with Kajsa

Kajsa was chosen as a respondent due to her profession as a care responsible nurse and with
the knowledge she has about the daily operations. She joined Three Foundations back in year
2012 and has prior experience from working within acute care (hospital) since 2009.

A typical weekday starts with Kajsa going through the night’s events with the night shift
personnel and it continues with her looking at today’s schedule to see what is planned and if
something needs to be discussed with her team. She works with risk assessment related to
nutrition, decubitus, oral care and the risk of falling among many things. Kajsa coordinates
with the municipality and holds weekly meetings with a physician.

The respondent is not sure about how much time she spends on data input, but she has never
spent more than three hours doing it (an extremely rough estimate!). She is well aware of why
she needs to add certain data into the system. Some data is entered because of laws and
regulations and some information is entered so that any other nurse can give the same quality
of care to the resident if she was unable to show up for any reason. When asked about what
she would find value adding to her daily work in terms of technology, she stressed that it
would be good if you could enter all the data about, e.g. a new resident in one place instead of
writing the information into multiple systems. This together with a mobile solution to look at
the data would make the administration as well as the access to information easier. She
believes that technology can help to improve for both the personnel and residents of all ages.

People that move into the apartments’ now are more used to new technologies and know how
to use e.g. a cellular phone or a tablet. The modern residents strive for independence. Her
view of mechanical animals and wearables is that she believes that both of them can be
beneficial. However, she stresses that there still needs to be a purpose such as, helping the
resident. In the case of robotic animals it may lead to a peaceful environment and in the case
with wearables, this could make the resident feel more independent without the feeling of
being monitored. The monitoring aspect would make most sense during night time when there
are less staff working.

Some statistics are pulled out of the systems and the operational managers tend to look at it
for analysis purposes. She thinks that statistics is a good fundament to start a discussion rather
than just guessing. Her feeling is that the technological involvement within the elderly care
has more or less been standing still for the last decade until recently. With the help of
technology and statistics she has already seen how the care can move from reactive to
preventive care. Kajsa is open to new technologies and thinks that you should at least try
things out and evaluate if they are good or bad.

4.2.5 The Interview with Johan F

Johan works within an innovation team and has prior to his current position worked with both
the business related part of the company as well as the IT-focused. He does currently work
with web services and new concepts which is the reason for his participation in the study. Our
goal was to get some insights into how one of the products that the case company uses, works
in terms of data collection and how he looks at the future trends within modern elderly health care.

Identifi started out as a research project to solve a problem but was then commercialized. The principle is built on electricity and conductivity. When a saline solution gets in contact with the products core, sensors are registering metrics.

At the moment, only relevant data is collected to create a pattern for the customer (nursing homes) even though there are possibilities to add more sensors to the product. Each logger transmits data via APN, meaning that it connects to an IP-address via 3G.

As the assessment goes on for at least 72h and a lot of zero values are collected (where nothing happens). The zero values needs to be handled with algorithms in order to represent the data in a graph that can be read and interpreted by a human brain.

Johan stresses the importance of interactions between humans but thinks that devices such as mechanical animals and teddy bears can help with the emotional contact. When asked about the future of health care and how he believes that it may change, his response was he believed in more sensors, (attached to or inside the body) to understand every individual. He believes in Apps in the sense that they can specialize in particular areas in a cost effective way; something that was not possible until recently when you had to spend money on a whole system. A mentioned parallel to this is the Apple health kit where you can measure different metrics for your personal benefit. Since it is so easy to share the data collection with the rest of the world, by ticking a box, large amounts of data can be collected in order to look at the data with a research kit for a whole population where patterns (trends) can be found. This results in high quality data that is easy to get hold of.

It is important that we don’t start to collect data just to reach high volumes but to think about why we collect the data. Metrics within acute care or hospital care are more evident than within e.g. the elderly care that is more focused on caregiving. Hopefully, there will be other metrics to measure in the future that is not possible to find today, possibly automatically. An example of such metric would be how much time a caregiver manages to spend with an elderly beyond the time it takes do his or her job (quality time).
4.2.6 The interview with Anders

Anders has extensive experience within the field of research and analytics as well as from IT-project management from his years within the Government offices of Sweden. His attitude and passion for data, technology and optimization was a perfect match with our thesis work. This is the reason for why Anders was chosen as a respondent.

During the interview the power of good examples\(^1\) was discussed as a phenomenon. This phenomenon implies that there is a belief or a common understanding that the better example out of two automatically will be implemented. This is not the case as there is no Darwinism when it comes to this matter. A bad idea has been proven to spread just as fast as a good idea since there are no mechanisms such as survival of the fittest. To achieve sustainable improvement four criteria needs to be met:

1. You need enough insight and knowledge to understand that you need to improve.

2. There must be knowledge about alternative ways. A failure here will lead to denial, anxiety and prevarications. Good examples can be helpful but in order to really make a difference there must be knowledge about that an example really is good. It is not uncommon that there is a failure or lack of measurement before and/or after a change, something that makes it impossible to say whether something was good or bad as a change automatically doesn’t have to be for the better.

3. You need people with knowledge about change/improvement management within an organization. A method can sometimes become so corrupted during the implementation itself that it doesn’t work as it ought to. The organization may believe that to make it work in a better and more efficient way, it cannot be proved until some form of measurement has been made.

4. The last criterion to be met is to measure the output in terms of improvement and to keep it alive. It is not unusual that an organization returns to the old way of working after a year or two.

According to Ekholm “all data sources will become corrupted over time” as you sooner or later will find what you are looking for. Therefore multiple sources should be used and changed over time. For a long time, the only way to make analysis and create future trends has been some sort of regression analysis – a top-down approach. A couple of years ago, there was a possibility of an existing way to measure with a bottom-up approach in an effective way (e.g. through micro simulation models). Anders refers to social physics and argues that the mobile phone has contributed to this.

As long as no distribution needs to be made traditional regression analysis is sufficient but when it comes to more complex systems with turning points, microsimulation models are needed to make sense of the data. One of Anders daily tasks, is to approach the problem that needs to be solved. Usually a scatter plot diagram needs to be made to look for a cohesion. After that, tables are looked upon and some sort of regression model is made to look for correlations or causalities.

\(^1\) Free translation of the swedish De goda exemplens makt
Anders believes that visual analysis will be vital to make good analysis and still being able to understand them in the future; or as Anders puts it:

“The eyes are the broadest bandwidth to the brain”

Thus the data needs to interact more with our senses in shapes and colors instead of diagrams (e.g. the color green is easier to understand than the absolute value 0.72). In order to take the next leap forward within welfare analysis, a massive amount of data and good models are needed. As an example, Anders refers to the school system in Sweden where about 10% of the 9th graders fail to fulfill the goals to pass the ninth grade. This has been the case since the 70’s and has not changed for the better or the worse since. As proven by this example, the industrial organizational methods have been insufficient (more than three decades have passed by) and new methods need to be developed to look at this complex sector.

The health care paradox: As new technology and new ways to treat diseases appears, people will ask for it (a new demand arises). Technical progression will result in higher costs and higher demands on financing. There is currently a lack of dynamics between the technical progression and the speed in which old technology is being replaced. If 99% of the old systems could be updated or replaced more rapidly, the funds to finance the new systems (1%) would be enough. What has happened is that there are more to choose from than ever before, bigger volumes and lower prices; all of this at once. This is nothing specific for health care or the elderly care but a general problem in many industries. The new technology is not the problem, but more so, of the slow speed in which the old technology is being replaced.

Complexity management: In order to analyze complex dynamic environments such as the elderly care a lot of data is needed. The former industry models to analyze do not work anymore due to the complex nature and only since a short while back, the possibility to make good analysis of such matters exist. Too much effort to industrialize complex matters is not unusual while concurrent, too little effort is put into industrializing none complex matters that probably could and should be industrialized. Ekholm believes that the only way to deal with complexity is through a lot of real-time data (Big Data) and machine learning. He believes that health care or specifically the elderly care is a complex matter. There is an interaction between the elderly, the personnel, the relatives and the elderly care. In his opinion, the same system will provide both good and bad results.

With an example concerning dilapidation he explains that a system that provides care normally provides good care. When looking for what went wrong, the normal or old approach is trying to find a specific reason. In this system, if one person misses out on something, the next one will compensate for this if he or she takes notice. This creates a robust system but sometimes it might happen that the next person doesn’t reflect and compensate for the error; as the error is small and lies within or close to the system boundaries, of what is considered to be accepted. The dilapidation could therefore be a coincidence as everything works well in 90% of the cases. The system output has changed and in order to understand a self-organizing adaptive system such as the health care system, there must be an understanding of the resonance within the system. That is, how everything is connected and what might happen with the output and the other variables if one variable is altered. To understand these interactions a huge amount of data is needed and one way to do this is through social physics. By analyzing how ideas flow throughout an organization the speed and amount can be influenced. As an example, the speed or amount of ideas exchanged could be increased with an alternation of the times when different people in an organization have their coffee breaks.
Ekholm stresses the importance of measuring and to make sure that the improvement must be a part of the process. He refers to the institute for health care improvement (ihi.org) that have a lot of information and research about how health care can be improved by data collection (measuring), experiments and continuous improvements. Anders does not believe that an annual measurement (e.g. an annual survey once a year) will make that much of a difference as the measurement needs to be made continuously for us to see that we are moving in the right direction. It is of great importance that an analyst, next to knowledge, understands about statistics and how to make good analysis and interpretations from the dataset and the business. This double competence (knowledge about the business and statistics/analytics) cannot easily be bought as a service from a consultancy firm. Thus, to get a good understanding of complex systems, a bottom up approach is becoming more of a requisite than an option.

The way to analyze data overall, has to do with the desired outcome or result. Exploratory analysis, e.g. through data mining to find correlations in the data can be used if there is no or little knowledge about what the goal of the analysis is. If there is a thought or an idea of what might be found (you are aware of that you have a problem), Anders agrees that a framework such as SMART can be used.

**4.2.7 Testing the SMART framework (2015)**

A small test was made to obtain practical experience and an overview of the SMART framework. Figure 7 shows the working model how to approach an organizations' data. The outcome of the initial questions was that the organization collected a great deal of data from different sources such as the system MCSS and the alarm system. The data is stored in a relational database which transforms it digitally and is structured ready for analysis.
The data was when normal looked upon with the corresponding software, hence we believed strongly that there was a way to harness more information from the data. As a result, we asked Three Foundations for access to a data source. Within the framework of the study access to the database of transactions from MCSS for all alarms were granted. The data from MCSS was more of a challenge to clean up and mask as it would be unethical to expose the medical condition of an individual person. Thus, the data about the triggered alarms can be narrowed down to a room then it would be better to show an example on a higher hierarchical level. Because of the requirements regarding anonymity a decision was taken to keep it at a ward level. After receiving the data and after promising to not leave the data to any 3rd party the study begun with a strategy.

Start with a strategy: By looking at the SMART Strategy board we managed to figure out our purpose and ambition.

- The purpose with this field study was to show how it is possible to go beyond the limitations of the out of the box programs, that comes with the alarm system to perform analysis of the transactions in a faster and easier way. We did also intend to leave some sort of deliverable such as a diagram.

- The vision was to get an answer to our second research question, to show how can a specific nursery home make better use of their collected data and if the current setup can be used in another way.
The analysis was made with the support of a tool called Tableau (version 9.0). The program is developed by a company called Tableau software (2015) with the mission to “help people see and understand data” (Tableau software, 2015). This philosophy and what we were trying to do was a perfect match. Academic licenses to the program were obtained. Furthermore, after some research it became clear that this is a popular software challenging and changing the landscape of self-service BI.

**Measure metrics and data:** Structured internal user generated data stored in a relational database (RDMS) were used. The structured nature of the data made it straightforward to work with. Thus, it does also make it possible to connect directly to the source for real time updates.

**Table 1: Answer to the SMART questions.**

<table>
<thead>
<tr>
<th><strong>SMART Questions You want to Answer:</strong></th>
<th><strong>Data sources that will help you answer the SMART Question</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of data set</td>
<td>Emergency alarms</td>
</tr>
<tr>
<td>Decrbe type of data</td>
<td>Transactions from the alarm system. Triggered alarms from a period of three years</td>
</tr>
<tr>
<td>Location &amp; Ownership: internal/external</td>
<td>Internal</td>
</tr>
<tr>
<td>Format: Structured/Unstructured</td>
<td>Structured</td>
</tr>
<tr>
<td>What is the data collection method?</td>
<td>The resident presses a button</td>
</tr>
<tr>
<td>Where is the data stored or located?</td>
<td>on a MSSQL server</td>
</tr>
<tr>
<td>Describe the data volumes</td>
<td>Big but not huge if you count all the alarm types</td>
</tr>
<tr>
<td>Describe data Velocity/Frequency/Recency</td>
<td>real time / every day / real time</td>
</tr>
<tr>
<td>Describe data Veracity/Quality</td>
<td>Structured and numeric, good quality</td>
</tr>
<tr>
<td>How will the data be analysed?</td>
<td>Through Tableau, a direct connection to the database</td>
</tr>
<tr>
<td>Costs associated with capturing, storing and analysing the data</td>
<td>for this project, none</td>
</tr>
</tbody>
</table>

**Apply analytics:** In this particular case no sort of combined analytics were used as we only dealt with a single dataset. With multiple datasets other methods could have been used. However, this case was dealing with measurement values and did not need any complex algorithms. The use of the basic mathematical functions SUM, COUNT and AVERAGE were enough in this case.

**Report Results:** As mentioned in the strategy, Tableau software was used to visualize the data. The data visualization was done through simple graphs. The first graph (appendix c) shows wards with the highest number of emergency alarms triggered between July and December, 2014. The color intensity (red) and size of a circle indicates the amount of alarms triggered. The higher amount of color a circle has, the more alarm was triggered. The second graph (appendix D) goes more into detail and looks at the top 3 wards with the focus on alarms per day. A sample of two months was used to illustrate this, July and august but more months could be added into the filtered result.
**Transform business:** By looking at the report (results) from the analysis the company can start to look into what causes the variations in the graphs. This is only the data present and each matter connected to it is essential and taken into account. The graph only shows the data from an objective perspective.

4.2.8 Issues

In the field study it became clear that immense data was being captured. However, the problem was to use the data in a productive way. The systems could show some graphs and statistics but there was a thought and a willingness to do more with it. The field study company was about to digitalize their food ordering process, something that would generate more data that could be captured. They wanted to use the data to achieve their goal, to maximize the wellness of their residents. The problem however lies in the definition of what you want to measure. Without a clear definition it is hard to measure because everyone can have a different understanding. Wellness for instance, should that be defined as freedom or is it something else? A clear strategy needs to be made with proper definitions and a common understanding of what the aim is.

We learned that initially there was an issue with the dataset. Without the proper knowledge we could only show the statistics without making any good nor qualified analysis. Looking back at the interviews, a good idea would have been to send out the interview questions before the interview itself to get an even more in depth discussion. Five interviews were enough to write the thesis but to improve the quality of this study more interviews should have been made.

The subject was a hot topic during the period of time in which the thesis was written and new information and insights were presented on the web on a daily basis. With this in mind we needed to filter what to use in the thesis.
5. Analysis

The data from interviewees were analyzed with thematic analysis. This chapter will present this thesis finding and followed by new empirical findings. The following chapter describes the result of the analysis that took place, with the help of the template deliverable from the template analysis.

5.1 Template analysis

The different thematic was used to divide the next chapter into paragraphs. The codes were written as chapters in the template and are more used as guidance to connect the themes to the collected data for the report. The following chapter uses the identified themes as foundation and the codes as guidance to create an analysis of the interviews. The relevant information for this study found on coding level was rewritten to a theme level. A text on a coding level would have been too detail orientated and too complex to understand. Appendix B shows an overview of the template.

5.1.1 Data analysis and digital devices

Data collection and data collection: The study came across two types of data; structured and unstructured. Structured data can often be found in relational databases and is easy to work with due to its structured nature. Unstructured data is increasing and is anything that is not considered to be structured. This kind of data is made out of e.g. medical journals or texts. Possibly due to the heavy increase of (unstructured) data available and the methods used to capture this kind of data, Big Data has grown to become a business of its own. In research, Big Data is characterized by the four V’s: Volume (scale of data), Variety, (different forms of data) Velocity (analysis of streaming data) and Veracity (uncertainty of data). A considerable amount of data is not of good quality or of any use, e.g. only about 10 percent of the data in a company is valuable data that can be used today.

In order to achieve high quality and relevant data we need to look at the data that we collect and store. As mentioned earlier, as not all data is relevant, it might be a good idea to start by looking for a strategy about what we want to use the data for, to commence progress. The SMART framework by Marr can help to set a strategy by collecting the proper data, the quality can be increased as the business will be able to focus on that data (keeping in mind that 90% of the data collected is irrelevant). To avoid the collection of everything some sort of data governance is needed, on what level is up to the company and the cause that you are on to, but some kind of data steward within the organization would be good to have. The problem is not the amount of data to collect (as seen in the field study case), the problem is to find out what to collect (the right type of data). The new technologies and the computing power lets us collect new sorts of data. Earlier, we were bound to look at structured data (such as tables in a relational database or in excel sheets) but now we are also able to make use of non-structured data. Data like this can be from journals or digital bread crumbs (such as the trace you leave behind when search for something at Google or liking somewhat on Facebook).

Infrastructure: It was clear that there is a lot of data out there and the amount is increasing rapidly. As mentioned in the interviews by e.g. Ekholm the health care business is complex
and the only way to understand the kind of complexity is by looking at a lot of data. Previously the data was stored on computers but have now technology has advanced to store data into the cloud for more people to use. A good example of this was mentioned in the interview with Johan F, where he referred to the Apple health kit. The aggregated data from one person can be accessed by a physician or the anonymized of millions can be accessed by the public domain after the individual has granted the collection from his or her device. The data needs to be valid and reliable in order to be of any use.

Digital devices have become part of society and has changed the world. For an instance smartphone’s- a technology which has several devices packed into one hardware. The mobile smartphone, its apps and the constant connection to “the cloud”, has in some cases moved the data from personal physical hard drives.

**Analysis:** With the proper tools such as data mining software or software for analysis, the data can be transformed into results. This can be done through e.g. Multivariate data analysis, where you look upon all the data simultaneously, regression analysis or via pattern recognition with the help of sophisticated computer algorithms (e.g. for data mining or/and machine learning). According to Johan, Johan F and Ekholm the data has to be reliable of relevance to the purpose. However, the huge amount of data and the complexity require new approaches such as social physics. A comprehensive way to look at the data is through visual analysis. Key performance indicators may change over time since the new metrics can be found with better technology. With the help of software, the results can be transformed into graphs and visualizations that can be interpreted and understood by humans to achieve insights. The insights can then be used to make changes to the current setup.

**Soft values:** During the interview with Kajsa, she mentioned that residents have a physician visiting on a weekly basis. A more accurate diagnosis from a weekly physician and the help from the clinical decision support system (CDSS) can lead to correct the help faster. Also, an important factor that Johan R mentioned, was wellness amongst their residents. In order to increase the resident's stay at the nursing home there are numerous factors that affect residents well-being. In this thesis a few of them are mentioned that may improve their way of living. For instance, with data analysis and sensors the staff do not need disturb residents unnecessarily, especially during the night time. From an ethical point of view, Johan argues that working with technology generates a hard but an important task; to create balance between increasing the safety among the residents and the violation of integrity.

### 5.2 Summary compared with theoretical concepts

In the interview with Johan R and Johan, it was clear that sensors is a big deal for the future. With the support of the sensor devices that are cheaper than they ever have been, it is now possible to get insight about an individual's health status on a much more detailed level. The new devices let a doctor or a nurse get insights without being in the same room as the individual, something that lets the elderly feel less monitore. Instead of waking up a resident in the middle night time, the pulse and heart rate can be measured through sensors. As a result, the individual may get more qualitative sleep and improved wellness. Kajsa understands the importance of sensors and monitoring this in her work, it would make sense to use during night time when the number of employees is low. This confirms the theoretical concepts 1 and 6:
✓ “Data analysis combined with Electrocardiograph (heart rate) monitoring could be used at a nursing home.” (Hak Jong et al, 2008).
✓ “Data analysis from collected data with ingestible sensors and personal monitor can be helpful for elderly.” (DiCarlo et al, 2012).

Kajsa also says that the elderly want to feel independent and live free of someone always watching their back. Johan R mentioned that the most important goal for the Three Foundations, is to make the last time for each and every individual's life as good as it can possibly be. This confirms theoretical concepts 2 and 11:

✓ “Health monitor device with the size as watch can with conjunction of data analysis be used in a nursing home to detect person's well-being and detect events (such as falls or collapses) that trigger alarm.” (Frank G. Miskelly, 2001).
✓ “Sensors can improve the quality and health care in a nursing home.” (Grossglauser and Saner, 2014).

The interview with Olof concludes that if there is large amount of structured data, multivariate data analysis is a great tool especially if you have more than one variable. Hence, it can be a good start when looking for correlations. When predictive models are generated through software such as Simca we can plot the different variables and look for outliers. Also Johan R claims in his interview that they have large amount of data over a three year period. This confirms theoretical concept 4:

✓ “Multivariate data analysis as a data analytics tool in a nursing home.” (Swarbrick & Camo Software 2012).

Kajsa also mentioned that the elderly residents have tendency to fall and have to manually call for help. This confirms theoretical concept 5:

✓ “Data analysis with digital devices (video monitoring) can automatically trigger an alarm to call for help.” (Khawandi et al, 2010).

Additionally, Anders presents an argument about when to use data mining and when to use exploratory analysis methods. The interview with Anders shows that the SMART framework is great when you know there is a problem and want to locate the root cause. This is a concept of how to respond to a problem and is independent of whether it is structured or unstructured data. You need to come up with what you are looking for. The analysis itself is not that difficult, it is our right to ask any (relevant) issues. The staff is very business-related and have an understanding of what the data is used for. This means that they can draw good conclusions from the data collected. There is also an awareness that data are a good basis for further discussion which confirms theoretical concepts 3 and 7:

✓ “The SMART concept as a data analytics methodology in a nursing home” (Marr, 2015).
✓ “Use data mining as a tool for extracting valuable data in a nursing home.” (Connolly & Begg, 2010).
Kajsa describes in the interview that the nursing home has a visiting doctor once a week to check up. We believe that if the data about the resident's symptoms were stored continuously it would speed up the process. Also, we believe they need a system that can interpret already stored data, for instance, if one of the residents is allergic to something in the food. If so, this confirms theoretical concept 8:

✓ “The nursing home can use clinical decision support system (CDSS) to help speed up health care process.” (Graber and Mathew, 2007).

According to the interview with Anders Ekholm, he claims if data analysis has an explorative approach SEMMA are an excellent tool to recognize patterns. This confirms theoretical concept 9:

✓ “The SEMMA methodology could be used to extract information from data at a nursing home.” (Obenshain, 2004).

Anders Ekholm believes that social physics can be tooled to manage complexity as the current methods developed from the industry are insufficient. Big data is the engine for Social Physics and by analyzing the digital breadcrumbs about how ideas spread among people we might be able to get a better understanding of complex elements. This confirms theoretical concepts 10:

✓ “Social Physics as a new way of analyzing behavior and the spread of ideas” (Pentland, 2014).
6. Discussion

Based on the findings of this case study it can be argued that with the right tools, data analysis can be an important tool in the future. The difficult part is not to get hold of data, but how to use it in an effective way and make good decisions. The importance of asking the right questions and to find out what the organization wants to know was evident. The variety of tools presented in this paper have been proven to be achievable for this case study nursing home. An important factor to enable analytics is the amount of data available. Although data analysis has existed for a long time, it has changed to become a very important tool, especially in the health care sector where the demands increase with an aging population. Also, digital devices may have an important role because of their ability to collect large amounts of data.

Despite the case study with five respondents from different fields of work, it was not clear to us whether data analysis can help other nursing homes or not since various nursing homes may have different requirements which impose different questions. Thus, with several case studies of nursing homes an understanding of conjunctions of the common requirements and issues can be established. The prospects with further case studies of other nursing homes may contribute to improve the result as the one in the study already had a substantial amount of digitalized data. As mentioned earlier, one of the drivers for analytics is the amount and quality of data available.

As digital devices and the amount of data increases in the future there will be no such thing as big data, just data. The importance to define what we mean is great due to unstructured data in some cases. Variations and misinterpretations (different interpretations from language, misunderstandings or lack of knowledge) can lead to that we find something that is not there or find something not related to what the initial question was all about.

6.1 Research questions and purpose

The primary goal of this paper was as to explore how the nursing home (where this case study was done) can extract data from digital devices to improve their care and services. Also, the purpose of this study was to investigate how this nursing home can use data analysis to make good decisions. Furthermore, the questions about how a nursing home can make better use of its collected data and the importance of analysis of data had to be answered.

Looking at how data can be extracted from digital devices, the simple answer is that this is not a problem at all. The amount of data generated by digital devices is huge and increases by each day as the technology leaps forward. The difficulty is to use the data and use the result to implement a sustainable change. Improvement programs may change the daily business, but it is not uncommon that a business goes back to the way they used to do something within two years. Failure to measure before and/ or after the change makes it possible to know whether this was an actual improvement or not.

In this particular case the use of collected data could be improved with another approach towards the data with an external tool such as Tableau in the field study. However, different nursing homes have various requirements and prerequisites and this study did only focus on
one in particular. Due to a single nursing home, it is difficult for us to generalize. In our case, the nursing home had mature digital environment and this made it easier to harness the data in a better way.

With an aging population and the number of adults aged 65 and over that will outnumber children under the age of 5, there will be less people available to take care of the elderly. To bridge this gap help is needed and technology can be one of these means. The world is growing more complex as the population grows and the technology becomes a greater part of our everyday life. This complexity is hard to fully understand by humans, but can be interpreted with the help of a massive amount of data and analysis. An increased understanding may lead to preventive care.

Given the sources that we have come in contact with, we had to make a judgement of what was important and relevant to the thesis. Several theories are related to each other and sometimes, it has been difficult to separate what is relevant. Our judgement is that we have done a fair assessment from a digital health perspective and its system boundaries.

6.2 Limitations and method discussion

For the case study template analysis was chosen to analyze the theory and put it in relation to the findings with the performed interviews. The method itself is straightforward and logical from start to finish.

From previous work with the creation and design of databases, both of the authors found similarities with the template analysis methodology. The coding and creation of themes was similar to the creation of tables and attributes. There was no doubt that this way of thinking could be applied when trying to connect one theme with another in a logical way. The lowest common denominator will then be the connection that links one theme to another (comparable with a primary or foreign key in a database). However, a risk with such thinking is that a researcher might tend to make up connections to link two themes together.

Even though the interviews lasted for about forty minutes in average (lasting from twenty to sixty-five minutes), the sample was too small to make any sustainable specific conclusions. However, from the qualitative interviews or discussions, much was learned. The area of analytics and data collection is broad and during the few months spent on the thesis, the area expanded even more with new technologies and partnerships that have been seen as impossible before (e.g. IBM combining their Watson Cloud solution with Apple’s health kit). The rapid evolvement of analytics and data makes it impossible for publishing companies and researchers to keep pace with the industry. It is therefore hard to find good recent and reliable sources.

The SMART framework by Marr (2015) was limited to the case study and used as a logical and holistic approach towards data analysis at the nursing home. The case study was done to show the nursing home how data analysis can be used to extract more value from the data that is already collected. However, since only one dataset (the alarms) was available, it was hard to set the strategy (emphasized in the framework) and figure out what to look for. It may have been better to use Multivariate data analysis or even data mining as a start to make a first exploration of the dataset. As mentioned by Anders in the interviews, an analyst requires both the analytical skills and valuable knowledge about the dataset to go from good to great. As it
turns out a lack of the latter (as connection to the database holding the information through the Tableau application without any prior knowledge about the dataset) affected the outcome. The guidance from Johan R concerning the meaning of the different alarms was helpful. However, in order to make a good analysis we would need to know more about issues adjacent to the alarms (such as training of staff, or anything related to the alarm system).

6.3 Conclusion
This study has reviewed different theory aspects which demonstrates how make use of data for a specific nursing home. The benefit of using data analysis can reveal new information that may lead to other and better decisions for the organization. The consequence of these decisions could lead to increased quality of life for the residents.

The findings from this thesis work has raised the following bullet points about data analysis for a nursing home:

- Strategy is of great importance when analyzing data.
- Understand what type of data that is being dealt with.
- Consider the laws and regulations.
- Data analysis in the elderly care leads to increased diversity regarding expert knowledge required.
- Know your dataset, know your business.
- Existing industrial methods are not sufficient to understand an increasingly complex world.
- It seems that the technology might create two sides within an organization (one hi-tech focused and one empathy focused).
- This is a future business; major companies such as IBM and Apple put many resources into data analytics in health care.

6.4 Recommendation for further research
As been discussed during this study many questions have been raised. Therefore, further research in this area consists of following suggestions.

- **Information- and internet security and integrity**
  How to store data in a secure way that does not violate integrity.
- **Decision Support Systems and statistical methods**
  Statistics is a vital part of analysis and decision making.
- **Machine learning**
  Year 2015 was mentioned as “the” machine learning year. With the amount of data and the power for computing this is an interesting area.
- **Big Data and Predictive analytics**
  Big data as mentioned today will most likely not be referred to as “Big Data” in the future but as data. This is one of the foundations for Predictive analytics.
- **Specific devices**
  Different questions and different data can be associated with different devices. There is no universal outcome.
- **Economy**
  Look at the elderly and health care from a macroeconomic perspective.
7. References


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Appendix A - Interview Guide

Respondent A - Johan

Could you tell us about your background, and what responsibilities you have at Three Foundations?

How come that you start working at Three Foundations?

What is the three Foundations operations today in relation to digital tools? Such as telephones, alarms, etc.

Has Three Foundations have access to data and if so, what type of data is stored (Such as text, video, audio, photos, medical record data)?

Also do you think it is large amount of data stored?

How are data collected at Three Foundations? For instance, it is done through surveys, digital devices, calls or conversations.

Do Three Foundations store as a data digital format or analog (paper and pencil)?
Is it structured to the extent that it is possible to analyze it?

What would you like to use the information for that you collect? Do you see any synergy effects?
Do you have a plan today to get there?

What data do you have today to reach the goal? What data do you need more to get there?

Who are your stakeholders? The goal is to create a better health care but which do you think is more affected / should be affected.

In your business you treat both soft and hard values (hygiene factors and statistics) how do you think you get a good mix between the two types of input data, and how much weight should be placed at each (between thumb and forefinger)?
Respondent B - Olof

Could you tell us a little about who you are and what you do?

Could you tell us a little about who you are and what you do?

What was it that caught your interest in what you do today (you have worked with chemistry as we understand it)?

How would you describe Multivariate Data Analysis?

When is Multivariate Data Analysis applicable?

How important is the data analysis for companies today?

How do you see if there is "garbage" and how can you prevent this?

Do you think you could apply Multivariate Data Analysis along with wireless devices / in health care?

Respondent C - Johan F

Please, tell us about who you are and something about your background?

We reached out to you since we were told about a product called TENA Identifi, can you tell us a bit more about it?

How does the data collection work in this product?

How does the data representation work?

What type of data is collected?

Is it possible to collect any other data than what is collected today? Please tell us if there is something we cannot write of what you are saying due to the commercial nature of the product.

How do you see the future of the modern health and/or elderly care?

Can you say something about how a general implementation of TENA Identifi is carried out?

What do you think about (Mobile) Apps?

What sort of data or metrics do you think will become important (or more important) in the future?

Which data or metrics do you think would be good to combine in order to get good insights? (Why)
Respondent D - Anders

What do you work with and why have you chosen it?

What do you have for background?

You mentioned in a speech that "there is no Darwinism of ideas" can you elaborate on this?

According to statistics we are getting older, and more. Can you develop health care paradox and how do you feel that you can respond to it in a good way?

You have said "The best data - are the ones that will be the best in business, if they can also implement" can you explain this?

What is your thoughts how to use collected data in a good way? What should you consider, traps (both practical and statistical - distortion)?

How important do you think the data analysis is in eldercare? Why do you like this? How do you see the future?

You have talked a lot about micro-simulation models. Can you compare this with agent-based modeling?

How do you see the micro-simulation models in relation to other methods? Can you name some other methods that you think is good? (Good for if we want to build on the theory)

Is it possible to increase well-being with good and efficient data analysis?

Do you use / do you use any particular methodology when you must look for answers in a survey or in one or more data sets?

We have been in contact with the two methods in the context of our thesis, SMART and SEMMA. (We made a short presentation about these two before questions were asked)

What do you think of these methods? Pros and cons?

What kind of data collection method do you think will be effective tool in the future?

How do you think we look at the data in the future? Some argue, for example, that the visual data analysis will become more important due to the amount of data?

You told us a little about the complexity and Snowden's model; how "stupid" humans are and what we can perceive. Can you develop it?
"We already have analytics" - Deloitte showed that 90% of all companies have some type of analytics tool, but less than 7% think they get any measurable results from them. How use analysis tools in an effective way? What is your experience?

Some argue that classical B.I. checks only on historical data backwards while Big Data is more about looking forward. How do you see it?
Respondent E - Kajsa

Could you tell us about your background, and what responsibilities you have at Three Foundations?

Can you tell us about an ordinary day at work, what you do and how you are doing it?

How much time do you believe that you spend on data input?

Are you aware of what happens with all the information that you type into the systems; what is being used for and how it is being used?

If you would get to think out of the box without any limitations, what type of technological solution (with focus on information) would help you the most in your daily work?

What technological and non-technological helps you the most in your work today? (Open question - it is up to the respondent to interpret this question)

What is your opinion about how technology can contribute to help the residents?

If you have read the papers lately, there has been a lot of articles and such about “robot animals” in media e.g. chickens, seals, cats and now even teddy bears for cancer patients. What do you think about this sort of substitute for real beings?

What type of changes would you like to do that could be beneficial for both you as a staff member and the residents?

What is the most common “problem” that you bump into among the residents? (Falling down, toilet visits etc.)

Would you find it interesting to look at statistics of which rooms or areas that is in most need of help?

Would it be interesting with a bracelet (sensor) to monitor activity (e.g. sleep, pulse etc.)?

Would it be interesting to look at how a person is sleeping or when it usually wakes up through visual analysis or visual analysis methods?
Appendix B - The Template Analysis

1. DATA AND DATA COLLECTION

1.1 Types of data
   1.1.1 Structured and unstructured data
   1.1.2 Big Data
      1.1.2.1 what is big data?
      1.1.2.2 why big data?

1.2 What is data collection
   1.2.1 Why collect and store data
   1.2.2 How do you collect data
      1.2.2.1 Where to find data

1.3 Data Quality
   1.3.1 What is good quality data?
   1.3.2 How do we achieve and maintain good quality?
   1.3.3 Data Governance

2. INFRASTRUCTURE

2.1 Hardware
2.2 Storage data
   2.2.1 Databases
   2.2.2 The Cloud
2.3 Access data

3. ANALYSIS

3.1 Strategy and workflow
3.1.1 Measurements (KPI) and metric

3.2 Real time or stored data
3.3 Complexity
   3.3.1 Linear or complex

3.4 Machine learning
   3.4.1 Algorithms

3.5 Analytical approach
   3.5.1 Multivariate data analysis
      3.5.1.1 Simultaneously
   3.5.2 Pattern recognition
   3.5.3 Regression analysis
4. SOFT VALUES

4.1 Metrics
   4.1.1 Human interaction and emotional contact
   4.1.2 Human computer interaction (HCI)

4.2 Security
   5.2.1 Values
   5.2.2 Ethics

4.3 Users
   5.3.1 Threshold
   5.3.2 Understanding

4.4 Individuals
   5.4.1 Wellness

4.5 Working environment
   4.5.1 Special environment
Appendix C – Field study (Results)

Figure 8: Overview of emergency alarms.
Figure 9: Detailed view of emergency alarms (ward 3-5).