Mikael Ramstad Wenger

Innovation in the Home Help Services

How Enterprise Architecture and Enterprise Modeling can support the integration of telehomecare tools to enhance the provision of home care services

Master's thesis in Computer Science
Supervisor: Sobah Abbas Petersen
Co-supervisor: Anthony Junior Bokolo
June 2021

Master's thesis

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Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
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Abstract

Purpose of the study:
Telehomecare tools are suggested as a potential solution to bridging the gap between the current and desired states of the home help service provision, but implementation efforts have been impeded by the lack of infrastructure. Consequently, this thesis proposes an enterprise architecture (EA) framework to support interoperability and coordination in the digitalization of the home care services.

Method:
The thesis used a literature review to obtain an overview of the home help services, its technologies and problems it faces. The current and desired states were then modeled using the enterprise modeling approach For Enteprise Modeling (4EM) in conjunction with The Open Group Architectural Framework Architectural Development Method (TOGAF ADM).

Results:
The thesis presents possible technologies and solutions that can enhance coordination and interoperability within the home care enterprise, as well as the provision of home help services. More importantly, it offers an EA framework to support the implementation of these technologies.

Limitations:
Data was collected solely through literature, and other elicitation approaches are required to verify the architecture and its components. In addition, it requires a wider variety of actors for evaluation.

Contribution:
The thesis has explored central challenges to the home care service provision and how this can be addressed by implementing telehomecare tools with support from enterprise architecture and enterprise modeling. Furthermore, necessary requirements for the transition from institution-based care to home care are presented. Next, the implications of digitalization of sensitive patient data with regards to privacy and security are discussed. Lastly, the results of the analysis are presented holistically in a proposed EA framework.

Keywords:
Home care services, telehomecare, enterprise architecture, enterprise modeling, TOGAF, 4EM, interoperability

Sammendrag

Hensikten med oppgaven:
Telemedisin i hjemmet (telehomecare) er foreslått som en mulig løsning for å hjelpe overgangen mellom den nåværende og ønskede situasjonen i hjemmehjelptjenesten, men forsøk på å implementere dette har blitt hindret av manglende infrastruktur. Derfor foreslår denne oppgaven et virksomhetsarkitekturrammeverk for å støtte interoperabilitet og koordinasjon i digitaliseringen av hjemmehjelptjenesten.

Metode:
Oppgaven bruker et litteratursøk for å få en oversikt over hjemmehjelptjenesten, teknologiene den bruker og problemene den står ovenfor. Den nåværende og ønskede situasjonen ble modelert ved å bruke virksomhetsmodellering med For Enterprise Modeling (4EM) sammen med The Open Group Architectural Framework Architectural Development Method (TOGAF ADM).

Resultater:
Oppgaven presenterer mulige teknologier og løsninger som kan forbedre koordinasjon, interoperabilitet og tjenesteytelse i hjemmehjelptjenesten. Det mest sentrale resultatet er et foreslått virksomhetsarkitekturrammeverk som skal støtte implementasjonen av disse teknologiene.

Begrensninger:
Informasjonen ble kun hentet inn gjennom litteratur, og andre metoder for datainnsamling er nødvendig for å bekrefte nytteverdien til arkitekturen og dens komponenter. Videre er det nødvendig med et bredere utvalg av informanter for evalueringen.

Oppgavens bidrag:
Oppgaven har tatt for seg sentrale utfordringer i hjemmehjelptjenesten og sett på hvordan disse potensielt kan bli løst ved hjelp av telemedisin i hjemmet støttet av virksomhetsarkitektur og virksomhetsmodellering. Videre har den sett på hva som er nødvendig for at helsetjenesten kan gå fra å primært være institusjonsbasert til å i stor grad kunne bli utført i pasientenes hjem. Implikasjonene denne digitaliseringen bringer med i forhold til personvern og sikkerhet har også blitt diskutert. Til slutt har resultatet av analysen blitt presentert som en helhet i det foreslåtte virksomhetsarktitekturrammeverket.

Stikkord:
Hjemmehjelptjeneste, Telemedisin i hjemmet, Virksomhetsarkitektur, Virksomhetsmodellering, TOGAF, 4EM, interoperabilitet

Preface

This master thesis was written as a part of a Master program in Computer Science, at the Department of Computer and Information Science (IDI) at the Norwegian University of Science and Technology (NTNU).

Throughout the work with this thesis I have received a lot of assistance and support, for which I am very grateful.

First of all I would like thank my supervisor Sobah Abbas Petersen for giving me a challenging assignment and for guiding me through it with valuable feedback and inspiration. I would also like to thank my co-supervisor Anthony Junior Bokolo for his support and insight. The expertise they provided was invaluable and pushed me to sharpen my thinking which undoubtedly elevated the quality of my work. Also, in a year with very little social contact, their supportive natures, good mood and smiles have been reassuring.

I would also like to thank the people who agreed to evaluate the results of my thesis for their contribution. The knowledge and understanding they have of the domain, as well as their genuine interest in helping me achieve a good result, was truly inspiring.

I would like to thank all family and friends who have supported me with kind words, insight and support. It has driven me forward and helped me stay motivated.

I would especially like to thank my father, Arne Wenger, for his multiple read-throughs and hours on the phone.

Finally, I could not have completed the thesis without the love and support of my girlfriend Marte Hagen Solbrekken, who provided a sympathetic ear, stimulating discussions and cheerful distractions to rest my mind.

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Abbreviations

EA Enterprise Architecture

EAF Enterprise Architecture Framework

EM Enterprise Modeling

4EM For Enterprise Modeling

TOGAF The Open Group Architectural Framework

TOGAF ADM TOGAF Architectural Development Method

ICT Information and Communcation Technology

IT Information Technology

FEA Federal Enterprise Architecture

VRF/SIP Value Realization Framework/Simple Iterative Partitions

UML Unified Modeling Language

BPMN Business Process Modeling Notation

GDPR General Data Protection Regulation

WHO World's Health Organization

UN United Nations

SSB National Statistics Bureau (Norwegian: Statistisk Sentralbyrå)

CIA Confidence, Integrity and Availability

BMA British Medical Association

API Application Programming Interface

PET Privacy Enhancing Technology

MLS Multi Layer Server

TAM Technology Acceptance Model

TC Technical Component

1 Introduction

The health care system is currently facing a challenge of a population with an increasing number of elderly relative to the population. In Norway, the population has nearly doubled since the 1950s and in the same period the life expectancy has increased by nearly 10 years for both men and women[1]. With a life expectancy of 84.7 years for women and 81.2 years for men, the population is aging more rapidly than in the past. In addition, the proportion of elderly in the society has increased due to a decrease in mortality rates and according to the 2020 national population projections, Norway will, historically, have more elderly than children, as can be seen in Figure 1.1. Furthermore, it is projected that the proportion of elderly individuals in the Norwegian population over the age of 70 will almost double, from 670 000 individuals today to approximately 1.4 million by 2060[2]. This constitutes around 23 percent of the estimated total population in Norway in 2060. This poses a serious strain on the healthcare system, since the elderly are substantial consumers of primary health care services. In addition, elderly users of the health care services are more prone to chronic and non-communicable diseases which require periodical check-ups and treatments.[3]. Chronic diseases are closely interrelated with care dependency, regarding both the health of the patient and social aspects[4]. Furthermore, there is a close correlation between increased age and number of hospitalizations due to general physical decline[5]. Today, there is no well-functioning process on how to address these challenges and it results in long waiting times, overworked hospitals and unsustainable increase in cost[6]. Countries must therefore adapt to ensure that the health systems are ready for this demographic shift and align the health care to the needs of the elderly[7]. This requires the development of a sustainable system for long-term care, which requires a shift from the traditional institutional care to home-based care[8][9].

Thus, goal 1, which represents the root goal of the health sector regarding provision home home help services in this thesis, is:

G1: Ensure more patient are treated in their own homes.

In addition, the increase in individuals over the age of 80 is expected to be three times grater and the increase of population over the age of 90 is expected to reach five times its current size. This also has consequences for the potential support ratio, which indicates the proportion of individuals in the population that are elderly per individual that is in working age, where elderly is defined as individuals of age 65 years and older since this is the average pension age in Norway[2]. Today, this number is 0.33, but in 2049, this number is estimated to be between approximately 0.45 and 0.55, as can be seen in Figure 1.2. By taking the inverse of these numbers, it provides more tangible numbers, namely how many people are working per elderly individual. The results here are that there are 3.33 people per elderly now, but in 2049 this number is estimated to be between approximately 2.22 and 1.81. This means that the proportion of active workforce is reduced by almost 40% in comparison to the elderly population.

These changes represent a great achievement because they are mainly a result of improvements in the society such as medical advances, improved health care, better nutrition and more focus on sanitation, as well as better economy. Despite this, the shift in demographics may prove to be a potential liability for the sustainability of the health care system as the capacity could be pressured to its limits. The current home help service infrastructure will thus face serious constraints and goal 2 is:

G2: Facilitate more efficient provision of home care services

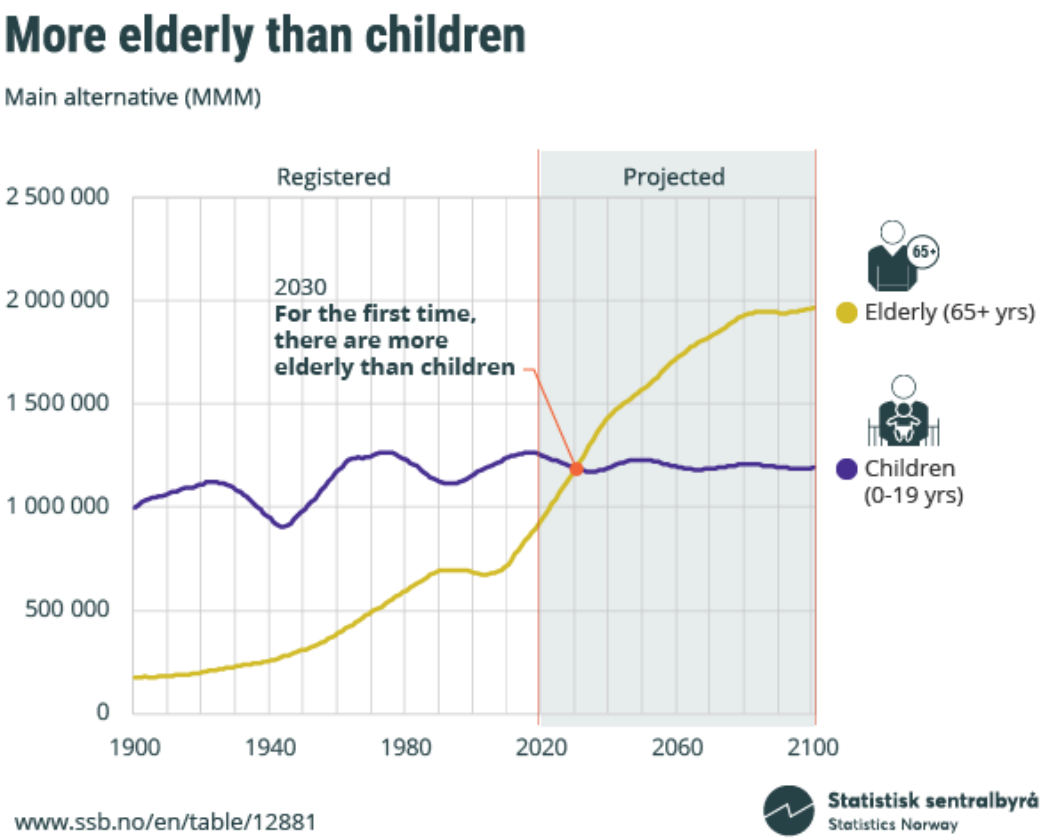

Figure 1.1: The Norwegian population will for the first time have more elderly than children

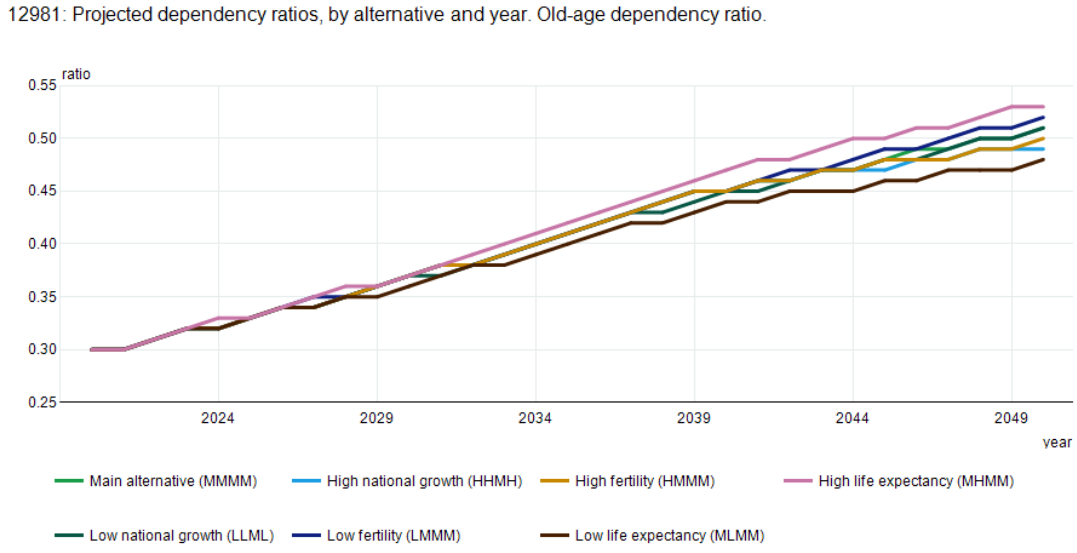

Figure 1.2: The ratio of elderly people in the population compared to the number of individuals in the working force

In Norway, individuals over the age of 60 constitutes about one-third of all patients admitted to general hospitals, and for individuals over the age of 70 this number is about one-fifth of the general population. The proportion of the former group has increased by approximately 2.6 percent (from approximately 31.7 percent in 2012 to approximately 34.3 percent in 2019). In addition, while the number of elderly individuals in the population is increasing, the number of nursing home beds have stayed relatively stable around 39 000 - 40 000 since 2008[1][10]. This means that the increasing proportion of elderly individuals will most probably lead to an increased demand for more nursing home beds. Thus, it is essential to try to prevent avoidable hospitalizations through an increased focus on preventative health care, preferably in the comfort of the patient's own home and goal 3 is:

G3: Reduce hospitalizations and admissions to institutions.

In addition, it is not feasible to provide home help services with the current system to this entire demographic due to a disproportion between elderly and home help nurses. However, if the individuals that are not able to stay at home are enabled more through technology, they could potentially get more autonomy in their homes and thus delay, or even prevent, the need for hospitalization or admission to nursing homes. For instance, by providing the home dwelling elderly individuals with sensors that the nurses and doctors involved could use, hospitalizations due to confusions and falls could be avoided. This shift could potentially be achieved through the introduction of telehomecare (telehealth in the home) tools such as sensors, reminders and alarms for the elderly and tools for communication and coordination for the health care personnel. This could also enable users to stay in their own homes as long as possible, thus reducing hospitalizations and improving self-management and quality of life.[11]

By providing the home help personnel with better tools for logging and monitoring, as well as to communicate with each other, the general practitioner and the hospital involved, the amount of duplicated work and time spent on tedious tasks that do not benefit the patients directly could be reduced dramatically. For instance, by introducing a common database that could be accessed by all health personnel involved (with the right authorization), they could be up to date on the patient's status and needs at all times. This could potentially save a lot of time going over information that does not change from time to time, such as the patient's medication, drinking habits and so on. In addition, the results from tests, diagnostics, treatments and complications could be instantly available and this could create more reassurance and safety for the patient, further increasing their comfort in their own homes and thus potentially reducing the need for a nursing home or hospitalization. By also sharing this data with the general practitioner and the hospital involved, the potential to discover early warnings of preventable deterioration or exacerbation increases, thus limiting how far the health decline can evolve before it is handled. This could prove beneficial not only for the patients, but also for the society as a whole, especially by limiting the demand for hospital (or nursing home) beds on the already strained health care system.

Attempts at implementing such solutions have, to this date, had limited success and evidence of effectiveness and efficiency still remains ambiguous[11]. The lack of a solid and holistic framework that addresses several levels of the system (such as technological, organizational and social), as well as its context, has limited its use in health and social care services. This could potentially lead to low investment and motivation for such projects which could in turn lead to project abandonment. Thus, it is important that a telehomecare program should be seen as an integrated part of the existing health care solutions and enhance the delivery of services as opposed to being another ad hoc solution piled on to the system. Furthermore, it is

necessary facilitate an alignment between the organizational and technological infrastructure, stakeholders and their needs and context surrounding the home help services, as well as the context in which it is developed. As of now, the current research on this is either based on empirical reports or through meta-analytic reviews. This means that there is a clear research gap when it comes to a systematic approach for a theoretical framework to provide the basis for these relationships as well as how to integrate the telehomecare solutions into the current models for home care delivery.

While it is evident that telehomecare could alleviate the issues that the home care services are currently facing, it requires the support of a solid framework. A possible solution could be to implement Enterprise Architecture, which may provide an holistic and systematic framework to aid in these challenges and provide the foundation needed for further work[12]. In this thesis, arguments for why (and how) an EA approach to telehomecare can be a possible solution will be provided. Then, a model based on the home help services' requirements will be provided. The urgent need for improvement of the home care systems in the health care sector makes it evident that this thesis will be a valuable contribution to the body of research.

1.1 Problem definition

The Norwegian government has established a national program for digitization of the home care services, and expectations are that the health care services should be more user centered[13][14]. This national goal serves as an incentive for leaders of the municipalities to implement changes locally. Thus, the leaders of the municipality must try to align the local initiatives with the priorities and focus areas that are defined by the government. However, much like the rest of the health care enterprise, home care services suffer from a lack of interoperability between the different levels of the hierarchy.

For instance, according to a case study from an urban municipality in Western Norway national strategies and policies affects the upper management's decisions, but the healthcare personnel that are directly providing the services are not familiar with the strategies surrounding the implementation of telehomecare.[15] The home care nurses also felt that their experiences on what needed to be implemented in order to deliver good services to the home care service users were not taken into account when strategies were developed. This process can be seen in Figure 4.8. In this model, it is evident that the creation of guidelines and their interpretation to local strategies is a one-way process passed down the hierarchy.

Furthermore, while the nurses were highly motivated to implement the telehomecare tools in their work, the lack of infrastructure hindered it. This implies that a central success factor for the implementation of telehomecare is a solid foundation and framework to foster organizational maturity. An example they provided was the fact that it was very hard to accurately describe a situation over the phone when conferring with emergency care or general practitioners. This could be attempted solved with sensors for blood pressure, pulse and oxygen saturation etc., and thus provide a much clearer picture of the situation.

The same case study also states that among the organizational issues that were revealed, lack of organizational maturity was a key factor to the slow uptake of telehomecare tools and technologies. The data infrastructure and resource availability were severely lacking and raised the question of whether or not the municipality was ready to implement the solutions that telehomecare could provide. Furthermore, despite the fact that the leaders of the municipality were guided by these national strategies, there were still a lot of factors, such as technological

infrastructure, that remained unclear as a result of a lack of national guidelines. The challenges related to implementation and integration were tied directly to this lack of national guidelines with regards to standardization of infrastructure and technological solutions, as well as organizational aspects. Thus, in order to successfully implement these technologies, a clear and hierarchical decision making structure that aligns strategies between all levels is necessary. Furthermore, there should be a set of national guidelines regarding standardization of technology, infrastructure and organizational aspects that are available to all levels of the enterprise.[16] This leads to Goal 4:

G4: Improve alignment of decisions and strategies within the hierarchy of the home help services

Lastly, the home care services are complex and "sosio-technical", meaning it involves both social and technological aspects.[15] Thus, the technical infrastructure and its components must be efficient and agile (able to respond to unexpected situations and changes easily and rapidly). The issue of developing a solution for such a complex enterprise is the fact that the business goals and processes, as well as the organizational objectives are often poorly aligned with the IT solutions. Failing to view the enterprise holistically can thus result in sub-optimal solutions that might solve an isolated, often technical issue for a small set of stakeholders concerned with only the technical part of the enterprise. Failing to include the business side of the enterprise could lead to a lacking commitment to the innovations and in the worst case lead to complete abandonment of projects[17]. This calls for a much higher focus on interoperability to ensure a mutual understanding between all stakeholders. In addition, all solutions must be developed holistically with good communication to ensure that the technical solutions align with the business processes and goals.

1.2 Research questions

Based on the previous sections, the research questions for this thesis are:

- RQ1: What is the current situation of the home help service provision?
- RQ2: What is the desired situation of the home help service provision?
- RQ3: How can telehomecare tools enhance the provision of home help services?
- RQ4: How can Enterprise Architecture and Enterprise Modeling support the integration of telehomecare tools in the home help services?
- RQ5: What modifications must be made to the CityXChange architecture for it to be used efficiently in the home help service provision.

1.3 Aim of the project

The thesis aims to explore the current and desired situations within the home help service provision through gap analysis. Then, the telehomecare tools that could bridge this gap are investigated. Lastly, it aims to illustrate how this digitalization can be supported by enterprise architecture and enterprise modeling. In addition, this document aims to include the following information:

- Enterprise architecture, particularly TOGAF and its architectural development method.
- Enterprise modeling, particularly the 4EM approach and its sub-models
- Data and security principles

1.4 Research objectives

The research objectives of this thesis are:

- RO1: Use literature review to get an overview of the current state of the home help service provision.
- RO2: Use TOGAF ADM and 4EM modeling to explore problems and opportunities in the current situation, as well as inefficiencies in business processes.
- RO3: Explore how the problems and inefficiencies could be solved and model a desired situation based on this using 4EM modeling language.
- RO4: Explore how the CityXChange architecture could be modified in order to meet the requirements of the desired situation of the home help service provision.
- RO5: Propose an enterprise architecture framework that meets the requirements of the home help service provision.

1.5 Structure of the thesis

The rest of the thesis is is structured as follows:

Chapter 2 explains the process of obtaining information for the basis of this thesis through a semi-structured literature review. It explains what telehomecare is and how it can be used to enhance provision of home care services. Then, enterprise architecture and enterprise modeling are explained before the relevant stakeholders are presented. Lastly, relevant related work is explored.

Chapter 3 presents the methods used in this thesis and starts with an introduction to the The Open Group Architectural Framework Architectural Development Model (TOGAF ADM) and how it is applied in combination with a literature review and enterprise modeling. Then, the details of how the literature review was conducted are presented. Lastly, the limitations of the methods used are explored.

Chapter 4 introduces models of the current situation and presents goals, processes and technical solutions as well as their challenges, problems and opportunities. The models serve as a foundation for a gap analysis with the desired situation, which is explored in chapter 5.

Chapter 5 presents the desired situation, based on the analysis from chapter 4. In this chapter the the models from chapter 4 are transformed to meet the needs of the stakeholders and demand for digitalization.

Chapter 6 presents the proposed enterprise architecture and its layers. It explains the stakeholder perspectives and data perspectives that run through all layers of the architecture. Lastly, the application of the enterprise architecture framework is illustrated by integrating the models from the analysis in chapter 5.

Chapter 7 presents the evaluation of the proposed enterprise architecture framework through a focus discussion and a Technology Acceptance Model questionnaire. The method and questions used are presented. Then, the results are discussed.

Chapter 8 concludes and summarizes the thesis and indicates possibilities for future work.

2 Literature review

A literature review is the systematic collection and combination of previous research.[18] The literature review was used in order to get an overview of the current situation in the provision of home help services and to identify barriers and problems as well as inefficiencies in processes. The purpose of the literature review was to establish sufficient knowledge of the home help services and explore how enterprise architecture and enterprise modeling could be used to increase interoperability and coordination within the enterprise. In addition an investigation and assessment of whether telehomecare tools could alleviate the problems identified and enhance the provision of services were carried out. Since the home help services is a very complex enterprise, it was appropriate to use a semi-systematic approach to the literature review[19]. The steps of the literature review is illustrated in Figure 2.1.

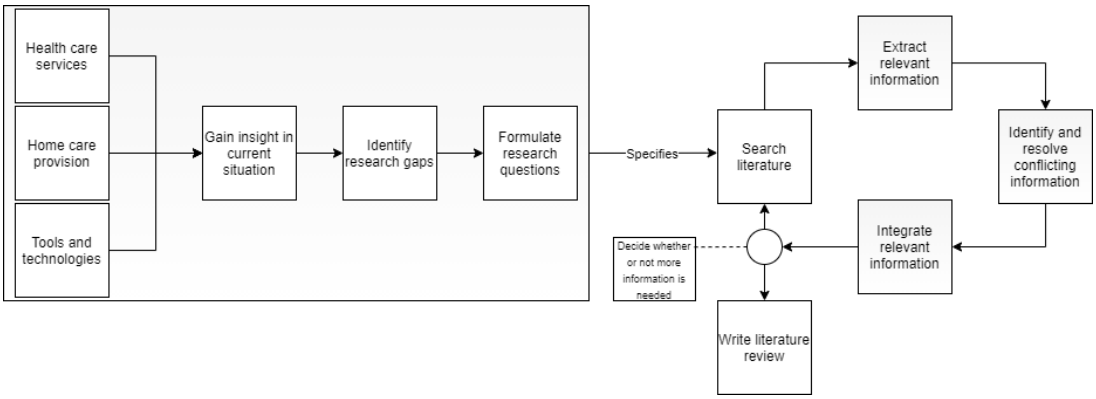

Figure 2.1: The steps of the literature review. The box on the left illustrates the initial review, while the loop on the right illustrates further research.

The first step of the literature review was to assess the current body of knowledge to identify research gaps and thus the contribution of this paper. Thus, the main focus was to get a broad understanding of the current solutions regarding the implementation of EA in the health care services and carve a path for further research. By getting an overview of the current state of the health industry, it was evident that there was a lack of research regarding EA in the home health service provision. This was a substantial gap considering the overarching goal of shifting health care towards the homes of the patients. Furthermore, the efforts to implement telehomecare tools often met barriers of poor organizational structure. In addition, the challenges that were outlined in the efforts to establish EA in the Norwegian health sector in general were related to poor alignment of business and technology, and most of the existing research was focused on coordination and interoperability of the Information and Communication Technology (ICT) solutions. By proposing a holistic approach to these issues, this thesis attempts to fill some of these research gaps.

The next step was to accumulate as much knowledge as possible on the specific topic of home help service provision and identify the current and desired situations. Although there were several articles and case studies addressing this, the focus was generally to identify challenges in the provision. Thus, there was no holistic overview connecting goals, opportunities and technical components that could provide insight in how it could be solved. This thesis will try to address this research gap by compiling this knowledge into structured models to illustrate the alignment of the business and technical perspectives.

Lastly, the technologies and tools that are applied in the current situation were reviewed with regards to their potential to be improved or replaced by alternative technologies. This also involved investigating potential telehomecare technologies that could be used to alleviate the problems that were identified. There is a plethora of possible combination of tools and technologies that is relevant to the home care service provision in the literature. Hence, the challenge here was to select a combination that could aid in achieving the desired situation and illustrate how they could be used to enhance the service provision.

Further details of how the literature review was carried out are described in subsection 3.2.

2.1 Telehomecare

The issues developed countries are facing regarding the provision of home help services include an increased demand of non-acute healthcare due to an increased number of chronic diseases as a result of a higher number of elderly. These chronic diseases means that in many cases hospitalization is not necessary and thus moving the provision of services out of hospitals and into the patients' homes will alleviate the hospitals and reduce health system costs[11][20]. In addition it is beneficial to the patients as many elderly prefer to manage their health and aging in their own homes rather than in an institution[21]. These challenges results in home health care being one of the fastest growing areas of health care provision, but the difficulties recruiting and retaining health care personnel for these services makes it hard to provide the patients with the support they need[20]. Thus, there is a need to implement information and communication technologies in order to provide high quality care in the patients' home. In order to achieve this, telehomecare is a viable and affordable support tool for innovation and organizational change[11]. It uses telecommunications and electronic information processing technologies to transmit relevant information and data to aid in the diagnosis and treatment of patients. By monitoring the patients daily, the home care personnel can detect early warning signs, prevent emergency department visits and reduce frequency of hospitalizations, which will in turn allow the patient to feel secure in their homes, thus improving their quality of life[22]. In addition to this, the provision of services on-sight will also have the potential to be improved since home care personnel can be provided with remote support within the homes of the patients. The latter includes IT tools and services for staff, patients and relatives, monitoring equipment (for instance wearable sensors), virtual visits and smart home technologies.

In most cases the elderly want to live at home, and with the increasing pressure on nursing home and hospital capacity, this is also the most ideal for the society[21]. However, the elderly patients could potentially be prone to falling, have limited mobility or they could be confused and forgetful. In this case, their homes are not the ideal place to be, and they could potentially have degeneration of these conditions without anyone picking up on it[23]. Thus, their homes become a threat to their health and well-being, and there is a need to improve their living environment. Telehomecare tools can significantly increase self-management and improve the patients' quality of life[24][25][26]. In addition, despite no reported decline in quality of care or patient satisfaction, the potential financial savings from fewer home visits and hospitalizations, as well as the reduced travel time outweighed the cost of implementing the telehomecare tools[27][28][29].

Telehomecare includes the use of information, communication and monitoring technologies that improve the health care personnel's provision of services in the patient's home, and which allow them to evaluate the home dwelling patient's health status remotely[30]. Thus, the health care personnel are able to deliver personalized healthcare from a distance through the use of for

instance sensors, alarms and reminders. In order to do this, the patient data should provide information about the state of the patient, such as heart rate or oxygen saturation. Simple monitoring devices could assess the patient's activity through for instance a pedometer and ensure that the activity is in line with the patient's medical regimen. It would also allow the health care personnel to monitor the patient's sleep schedule and body functions. This data should then be shared with all health care personnel involved and they should be able to access it instantaneously and remotely. This allows the different health care professionals involved to use their clinical skill to evaluate the data and provide personalized feedback that is shared with both other health care professionals involved with the patient as well as with the patient itself. The response is thus tailored to the situation and could be anything from digitally notifying the patient of a small adjustment in their medication to the provision of emergency personnel to the patient's home. The implications of security and privacy this introduces will be discussed in subsubsection 6.2.2.

This could be done both in real time and as asynchronous communication where patient data is aggregated and stored over time before being sent to the relevant health care professionals to aid in the diagnosis of a patient without requiring the presence of the patient[31]. An example of the latter could for instance be a stored collection of sensory data such as heart rate monitoring to look for deviations or signs of heart failure. When using asynchronous communication, traceability and timeliness, for instance through timestamps, are important to ensure that information is always synchronized. This ensures that health care personnel do not work with old information, which could lower the quality of care. Also, with regards to real time monitoring of patients, video consultations have been evaluated to be comparable to face-to-face encounters in terms of diagnostic accuracy and patient acceptance [32][33].

As a result of this aggregation of data, as well as the instant access to it for everyone involved, the telehomecare tools could also potentially allow the health care personnel to provide a much more comprehensive and immediate provision of services to the patient in their home. This means that health care personnel do not need to deal with unnecessary visits to the patients because they have a more in-depth understanding of the situation. A smart home with monitoring and sensors could assess tedious details that would otherwise be hard to predict, such as if the patient is not eating or whether or not they are taking their medication[34]. The sensors could also be crucial in a situation of crisis such as early detection of smoke or high values of carbon monoxide in the air. The patients themselves could also be notified of this on a device, such as their smartphone, and thus the health care personnel may not even be needed for the situation to be resolved. There is already a plethora of applications for smartphones to monitor health aspects such as activity and food habits that could potentially be incorporated into the home health service provision. If the patients are already familiar with such applications, the transition to telehomecare may prove to be smoother for them.

The motivation to introduce telehomecare solutions is that it could alleviate a lot of stress on a health care sector that is already stretched to capacity by improving and simplifying the processes within the home care services. To do this, the monitoring and treatment of chronic diseases should be redesigned in such a way that it fosters self-management and autonomy. In order for this to be achievable, the patients should feel safe in their own homes. The telehomecare tools will aid with this by alerting the health care personnel for support if the devices detect an issue with the patient[35]. An additional benefit of this is that a lot of unnecessary hospitalizations and home visits stem from the patients being nervous or confused. By having access to their data, health care professionals will have some concept of how serious

the situation is. Thus, they may potentially be enabled to calm the patient down remotely if the data shows that there are no health-related issues.

The existing home healthcare, where skilled health personnel personally visit the patients in their homes, is well established and broadly practiced. However, it is impossible to provide these services around the clock and it is thus possible to miss crucial information. In addition, the home care nurses mostly visit the patients alone, and if they are faced with deterioration or unexpected changes in the health of the patient, a lack of confidence and medical knowledge could make it hard to assess the condition of the patient accurately[36]. Furthermore, they are currently only able to consult with the patient's doctor over the phone, which could lead them to transfer the patient to diagnosis or care facilities to ensure that the patient is not in serious danger, even in cases when this is not necessary[16]. However, telehomecare could provide an alternative to physical visits or visits to a hospital or doctor's office by enabling the general practitioner to assess the health data of the patient. Furthermore, if a nurse is present, they could have the tools to transfer an image or video in order to evaluate ailments that are hard to monitor with sensors, such as skin lesions or a rash.

Another factor that telehomecare could address is the fact that a lot of home dwelling elderly are supported by their family or a caregiver, but that these family members or caregivers are rarely included in the details of treatment and condition of the patient[4][37]. This could potentially lead to a sense of isolation and hopelessness which could be incredibly stressful and potentially end in the transfer of the patient from their home to a nursing home. By including the caregiver in the group of people with access to information about the patient, it will not only help them understand the state of the patient, but they may also provide useful information that would otherwise be missed out on. This could allow the patient to stay in their homes for as long as possible. The implications of informal caregiver involvement is further discussed in subsection 2.4.

Telehomecare can thus alleviate a lot of the stress the current health care sector is experiencing, but it is important to emphasize that the implementation of telehomecare tools should be deliberate and precise. It should be integrated into the workflow of the home care service providers in such a way that it is not an add-on, but an improvement. If this fails, it could potentially end up being more time consuming and labor intensive than the current solutions and this could lead to abandonment. If the uptake of telehomecare solutions is not a joint effort from all layers of the hierarchy within the enterprise, with implemented training and technical support, the introduction of telehealth tools could be seen as disruptive, or even as a burden[38]. Fear of change could lead to unwillingness to share data, which would impede the provision of holistic home care provision and thus act as a barrier for innovation[39]. Therefore, a clear framework with solid guidelines is of paramount importance to ensure that everyone is on the same page with regards to how to achieve the full potential of the telehomecare solutions.

However, the current trend of telehomecare provision focuses mostly on monitoring vital signs and teleconsultations, leaving information access and communication relatively untouched. In addition, the decision support for staff or relatives visiting the patients' home, as well as for the patients themselves, is lackluster[20]. Furthermore, the information obtained through the virtual visits and monitoring of vital signs is rarely incorporated with other systems such as electronic patient records or decision support systems. On the contrary, the research conducted on information systems is often done separately and not in an integrated way. This has lead to challenges with document sharing within the home care services due to a lack of guidelines

and a common framework for communication. This means that the current research regarding telehealth to support the provision of home help services does not address how to combine information from different, and often incompatible, systems. Lastly, it lacks a set of common guidelines for practical implementation of home care service provision. This lack of guidelines and protocols for the application of telehomecare can potentially lead to home health personnel being unclear of their role and thus lead to internal conflict and concerns about the utility of telehomecare programs[22].

In an analysis of the telehomecare system in Ontario, Canada, several stakeholders reported that having such a system contributed to a higher sense of security, since they could take better care of their health at home, perhaps only with help from their informal care givers[11]. In addition to this, each home care nurse could provide three to five times more contact with the patients than physical visits[27]. The immediate access to a (home) health care provider reduced the anxiety and need for primary or emergency care for health concerns[37]. One stakeholder commented on the discharge from hospitals stating that *"When one was discharged from the hospital there never used to be real follow-up.. You felt like you were being dropped off a cliff"*[11]. The reduction in anxiety could be a result of patients being reassured that if there was need for help, the sensors would alert both them and the health care professionals[35]. As an added bonus, this reduced the amount of times the patients required the presence of health care personnel. In addition, the ability to send sensory data to the health care professionals enhanced the experience for both the home care personnel and the patients. Also, while the reduced need for home care personnel for observations and monitoring had the disadvantage of removing a social interaction for the patients, the visual features of telehealth facilitates a genuine relationship between patients and health care professionals[40].

However, issues with interoperability in the health sector are largely a result of poor coordination between different solutions and treating telehealth tools as ad hoc solutions could prove problematic[11][41]. Thus, there is a need for a detailed analysis of the home care provision domain and a solid framework that supports interoperability and coordination[42]. Furthermore, a framework will prevent fragmented solutions and information silos that can act as barriers to the provision of home care provision. In addition, to ensure that the telehealth efforts are governed properly by providing the management with an in-depth understanding of the home care enterprise as well as the technologies that could be implemented to enhance the health care provision[43]. This can be addressed by employing enterprise modeling to create a detailed overview of the enterprise and all its goals, processes, actors and technical components. In addition, enterprise architecture could provide support for the integration and standardization of solutions, which in turn aids the IT-business-alignment.[44].

2.2 Enterprise Architecture

An **enterprise** consists of the people working, information gathered and the technologies used and can include suppliers, customers and partners in addition to the organization or parts of the organization[45][46].

An **architecture** is used in order to get a visualization of the components of a system as well as how they are arranged and the interactions between them.

Thus, the **Enterprise Architecture** defines the primary components, stakeholders and goals of an enterprise and describes how these are related and work together.

The current home care service provision consist of several disparate clusters with information, strategies, systems and business plans.[47] This results in a lack of a common ground to give a corporate-wide sense of direction for all activities, processes and systems within the architecture. By implementing Enterprise Architecture, the provision of home care services can meet the digitization and centralization of information through a holistic approach and nurture interoperability and coordination[46]. In addition, the need for enhanced integration and standardization of solutions to counteract information silos and poor interoperability is evident[44]. Enterprise Architecture provides the enterprise with a holistic approach to planning and development of new solutions to achieve its goals by addressing the alignment between business and technology[43]. In addition, the implementation of an EA could be beneficial to provide a strategic context for further development of the enterprise in order to ensure efficiency and effectiveness and to face the changing requirements of the home help service domain. A major part of this is the facilitation of a common ground for the business and IT actors, which enhances the synergy between the IT solutions and the business processes and facilitates better strategy development and innovation[48]. This enables the enterprise to create more value in the services delivered by enhancing the IT solutions to better support the business processes, services and goals of the enterprise. In addition, it provides the enterprise with more flexibility to tackle changes in the external requirements, the business processes and the evolving technology, as well as the organizational structure[49]. Furthermore, applying EA to the enterprise prevents the duplication of work and resources by providing support for reusability and enhanced coordination[50]. Thus, it is beneficial to view the complex domain of home help service provision through the lens of EA highlight opportunities for organizational or technological improvements[51].

There are many types of enterprise architecture frameworks, the most popular being Zachman, FEA, VRF/SIP and TOGAF[52][53][54][55]. For this thesis, TOGAF was chosen as the architectural language. The Open Group has defined TOGAF as a layered EA governing tool with specific focus on the four subsets of business, data, application and technology. In a layered architecture, each layer supports the layer above it. The architecture can be expanded with more layers to ensure that all aspects of the enterprise are maintained. The CityXChange architecture is a layered architecture based on TOGAF, but with modifications and layers added to support the complex enterprise of a smart city[56][57][58]. Since the home help service provision is also highly complex, the additional layers of the architecture provides a more thorough framework for future development. In addition, many of the layers are concerned with perspectives that are central in the provision of home help services, such as the stakeholder perspective running through all layers. Since the ultimate goal of the home help services is to provide the best possible treatment to as many patients as possible, having the stakeholders play such an important role can prove beneficial. However, the architecture must be modified in order to fit in the home help service enterprise and the enterprise itself must be analyzed in order to identify its entities and their relationship. The analysis of the enterprise are in section 4 for the current situation and section 5 for the desired situation. Finally, the proposed architecture and its layers is presented in section 6.

In addition, a core concept of TOGAF is its architectural development method (ADM), which provides a process for developing architectures.The TOGAF ADM will be elaborated upon in subsection 3.1.

Enterprise architecture involves various stakeholders with different goals and prior knowledge, and applying it to an enterprise could therefore be challenging[59]. Thus, it is difficult to teach,

apply and specify the specific entities in a way that is understandable to all involved stakeholders. This can be addressed by applying enterprise modeling to analyze the enterprise and get an overview of its entities and relationships. Enterprise modeling is simple by design and was developed with the goal of being understandable for all involved actors. Thus, by combining TOGAF and EM, it can achieve alignment between the IT solutions and business processes and goals and reduce the complexity of the enterprise by providing a multi-dimensional representation of the enterprise, its entities and their relationships. This facilitates efficient knowledge exchange which in turn fosters better coordination and interoperability.

2.3 Enterprise modeling

The home help service enterprise is highly complex and thus to understand it better it is beneficial to break down its elements and structures, and reveal relations and dependencies. Traditionally, the modeling of technical solutions, through for instance Unified Modeling Language (UML), and business processes, though for instance Business Process Modeling Notation (BPMN), has been done separately, and thus failed to address the enterprise as a whole[60][61]. As a result, the technical components and information and communication technologies are not taken into account for strategy development, which could impede the efficiency in the enterprise and the quality of its services[62]. Furthermore, the success of these modeling approaches are varying in their intuitiveness[63]. Enterprise modeling is used for multi-dimensional analysis of the enterprise and results in a much more holistic overview of the enterprise that can be used to identify goals as well as shortcomings and problems hindering them in a way that is intuitive for the involved actors.[64]. EM also provides its user with a set of flexible work procedures to address the various perspectives of the enterprise, such as goals and strategies, business processes, IT-solutions etc., as well as the relationships between them. The overview and understandable syntax also alleviates the ambiguity of EA concepts and terminology, defines roles and responsibilities, and lessens the complexity of the EA framework, which have been impeding the implementation of EA in Norway[65]. Thus, it supports the EAs holistic approach to addressing the enterprise's challenges which in turn aids in aligning the strategy and goals with the technical solutions.

When assessing an enterprise using EM, the challenges with achieving a goal are identified and put in relation to the different perspectives and to what extent they need to be defined in order to address the issues and define possible solutions. Although each perspective is analyzed independently, the dependencies and relations between these perspectives must also be defined in order to ensure a holistic view of the enterprise and its challenges. For instance, the business processes should support the goals, and motivate the requirements of the technical components. Capturing all perspectives and integrating them into one analysis is the core functionality of EM[66].

The most important perspectives used in this thesis are the following:

- **Goals and problems perspective:** the enterprise must have a set of clearly defined goals that serve as a foundation for their strategy and evolution. In order to achieve the goals, problems, and which goals they hinder, must be defined. For this thesis, the opportunities to solve the problems were also included in this perspective.
- **The business process perspective:** the enterprise's business processes refers to activities that support the business goals. The processes must be continuously assessed and updated to ensure that the enterprise can achieve its goals. In this thesis, this perspec-

tive is combined with the actor perspective, which describes the involved stakeholders' responsibilities and tasks.

- **The concept perspective:** in order to ensure that all actors involved with the enterprise collectively work towards the achievement of the defined goals, a common definition of strategies, processes, services and other concepts are important. This will ensure that all communication and knowledge exchange is fluid and efficient, and that viable solutions do not fail because of misunderstandings or poor communication.
- **The technical components perspectives:** In order to ensure interoperability and reduce disparate solutions, the technical components that are used by the enterprise should be defined and standardized. This includes IT-systems and applications, hardware, digital storage and communication and information tools.

For this thesis the For Enterprise Modeling (4EM) method is used because it illustrates the different perspectives and how to work with EM without being developed within specific enterprises. It provides a more general approach and it is fairly easy to switch from 4EM to the established or preferred modeling languages and standards of the enterprise it was developed for[64]. An overview of the syntax used within the 4EM can be found in appendix:4em.

Since the model is based on the stakeholders' needs and requirements, it is crucial to ensure that the implementation of enterprise modeling focuses on and promotes their involvement[67]. The enterprise's management must therefore facilitate the inclusion of technical staff, home care personnel and patients when developing strategies and solutions. Thus, it is beneficial to explore the stakeholders relevant to this thesis. It is important to note that this is not an exhaustive list of relevant stakeholders, but rather a selection adequate for illustrating how EM and EA could be used to enhance provision of home help services.

2.4 Stakeholders

Stakeholders refer to persons or groups that must be considered when developing a system or architecture. From a sample of four hundred decisions, more than half failed mainly because decision makers failed to address the interest of their key stakeholders[68]. Identifying the stakeholders for this project will help with the direction it takes and with key decisions since satisfying key stakeholders will be paramount to ensure a rapid uptake of new solutions and prevent project abandonment. In addition, telehomecare solutions should be developed with the user in the center and thus be driven by their needs and requirements in order to ensure that the impact of the solutions are significant[11]. This entails not only a continuous dialogue with stakeholders about the integration of solutions, but also assessing their needs, capabilities and the environment in which the service provision takes place. Thus, it is important that the management have efficient communication with the health care providers who assess these needs, and that the strategies and guidelines are devised accordingly.

Patients

The first, and arguably most important, stakeholder is the patient. If they do not want to adopt the system to get aid, it will be near impossible to use it (except perhaps for internally in the health care organizations). The patients are defined as the home dwelling elderly patients and mainly the patients that would normally be admitted to a nursing home or a hospital, but that do not have to be admitted to such places with the aid that digitization and telehomecare tools can provide. This includes patients that are prone to falling, patients that are easily

confused or disoriented and patients with chronic diseases that are hard to manage without continuous monitoring. Thus, the new solution must take this user group into account.

For the patients it is important that they can stay in the comfort of their own homes for as long as they would like. Thus, it is important that they feel safe in their homes and that they can self-manage as much as possible. For this to be achievable, they must be able to easily communicate with the health care personnel and request aid with both health related issues and technical inquiries. In addition, the telehomecare tools should provide the patient with safety as well as tools for self-management through monitoring. They should also have the ability to access their own health related data to gain a deeper understanding of their current situation. This could in turn strengthen the self management even further. Lastly, the smart home solutions could provide autonomy and thus keep track of simple tasks such as taking medication etc., and by providing the patient with reminders through applications (for instance on a smart phone), this could both foster self management and provide autonomy.

Home care personnel
The second stakeholder group is also very important and includes care providers within the home health service provision industry such as nurses. If this group does not adopt the new system, it will never flourish. They all play an important role in providing care to as many patients as possible and thus their need is important to take into consideration.

For the home care personnel, the most important aspect is that they can communicate with both the patients and other health care personnel, such as the hospital or the general practitioner. In addition, they must be able to access and update relevant information digitally. This will allow them to be able to accurately assess the situation and make an informed choice. Furthermore, in addition to being able to access the patient's health data, they should also have access to notes and observations from other home care personnel if there are any. Lastly, they should be able to communicate issues and challenges they face in the patient's homes through all layers of the hierarchy and also be able to access information that is relevant to them directly from the source, no matter where in the hierarchy that is.

General practitioner
The general practitioner rely on being updated on their patient's health in order to provide the best possible treatment and thus it is also important with coordination and communication with other health care personnel. In addition to their involvement in the provision of home care, they are also dependent on being included in the diagnosis and treatments that happen at the hospital. The general practitioner generally has the most frequent contact with the patient and thus their insight in the patient's condition could be valuable to the treatment at the hospital. This will also foster continuation in the transitions to and from hospitalization, since the general practitioner does not have to wait for a medical report to get insight in the tests and treatments conducted at the hospital.

Hospital staff
Hospitals are complex and unpredictable work environments and time is often a constraint that the staff has to work around. Thus, the main motivation for them to be involved with the telehomecare services is the fact that having access to a comprehensive database of information on the patients can save them enormous amounts of time with regards to testing and diagnosis. By looking up information (as well as how recent it is), they can potentially avoid a lot of duplicated work which benefits both them and the patients. This could also be enhanced by the inclusion of the general practitioner, as discussed above.

Municipality leaders
For the municipality leaders, the main goal is to translate the national goals into local initiatives in order to align the health care service provision with the national priorities and focus areas. The main motivation for them to implement an EAF is to ensure transparency in strategy development. Furthermore, by enabling communication with the lower levels of the hierarchy, decisions could be more informed and based on the need of all stakeholders. This increases the chances of the uptake of innovation and thus reduces failure rates and in turn unnecessary spending of resources.

Informal caregivers
Elderly with care dependency are often looked after by informal caregivers, which is most often the patient's family. However, they are rarely integrated with the home care professionals, and are not given insight in the patient's health related data. Thus, it is challenging to cater to the patient's needs and facilitate long-term care. The high level of involvement combined with the severe decline in the patient's physical and mental capabilities can often lead to psychological distress for the caretakers[4]. Thus, the impact on informal caregivers' health must be addressed and there needs to be an assessment of how much new solutions should depend on their involvement.

In the focus discussion in section 7, it was also clear that the involvement of informal caregivers is a complex issue with several challenges. For instance, despite the central role informal caregivers have, they do not fit well into the current home help services, and legally they do not have access to information that could be relevant. This could further increase the stress of caring for patients, especially if they have deterioration like dementia since the patients themselves might not comprehend the situation of their condition. In addition, the informal caregivers are seldom given any training on how to support the patient, which leads to insecurity and feelings of aloneness[4]. For patients with severe mental deterioration, it could be challenging to gain an understanding of their condition if the informal caregivers are not given access to at least some information, such as a diagnosis of dementia. As such, arguments can be made for that the patients and their caregivers should be integrated as central actors in the design and implementation, as opposed to passive end-users[69].

However, there are more complexities than adjusting the legal boundaries to grant the informal caregivers more control over the treatment and access to all information regarding their condition. If, for instance, the caregiver was abusive it would be detrimental to shift more responsibility to them, and it could accelerate the patient's deterioration. Furthermore, there were cases where informal caregivers were given more access to the patient's finances and used this for their own personal gain. These are just a few of the perspectives that must be considered when discussing the desired solutions' dependency on informal caregivers and their involvement in the care for patients.

2.5 Related work

Findings from from the literature review indicate that although several efforts have been targeted at improving the services provided by the health care sector through the use of EA, they lack an holistic approach that integrates all levels of the enterprise. The focus is on the information and communication technology (ICT) solutions and how they are interrelated and not on how they are aligned with the processes and goals of the enterprise. This leads to issues regarding organizational commitment towards EA in all levels of the enterprise, which have been identified as a major barrier to the implementation efforts[17]. Furthermore, despite the

general agreement that the system should be developed around the needs of the stakeholders, the ICT-focused solutions do not address the stakeholder perspectives explicitly. The most relevant related work is summarized in the following paragraph.

Gjertsen et al. have carried out an investigation on home-dwelling elderly and factors that could lead to early hospitalization[5]. They also identified which patients had high frequencies of hospitalization. This could be central information when developing patient-centered solutions. In addition, key contextual factors in all levels of the hierarchy were explored[15]. The challenges of poor integration and interoperability, as well as the impact they have on the digitalization, were explored. They also stressed the importance of infrastructure to ensure that it is beneficial to implement the solutions. Lastly, they also investigated the health personnel's attitude towards adopting technology[16]. However, they do not explore frameworks to solve this or the integration of telehomecare tools with the support of an EAF
Furthermore, Ajer et al. have investigated central challenges with the current implementation of EA in Norway[70] [71]. Here, they explore issues outside of the technical and ICT-solutions, such as disparity in the knowledge of the system developers and the medical practitioners. Furthermore, they explore issues regarding the adoption of an enterprise-wide system, namely that the preference in the enterprise is to use local solutions rather than the nationally developed, standardized solutions. Wichmann et al. substantiates many of the arguments made by Ajer in a systematic literature review where the identified key issues pertain to the ICT-perspective and the reluctance the users within the enterprise have to adopt the new solutions[72]. Although they both touch upon problems regarding interoperability, neither explicitly suggest a framework that can enhance provision of services or aid in increased coordination and interoperability.
Lastly, the CityXChange project is a multi-national project for development of enterprise architecture to support the development of smart and sustainable cities[56]. The project is a part of the efforts to reduce emissions in order to reach the climate goals put forward in the Paris agreement[73]. The project focuses on building a holistic solution that includes technical solutions, users, buildings, the energy system etc., and how these factors impact the digitalization and development of smart cities[74]. However, this framework is not tailored towards the home help services and would thus need to be modified to be used efficiently.

3 Method

3.1 TOGAF ADM

The Open Group has defined an architectural development method (TOGAF ADM) as a recommended sequence of phases to be used when developing an architecture to ensure that the IT-solutions meet the business needs of an enterprise. The phases of the TOGAF ADM can be seen in Figure 3.1, where each phase addresses different concerns and architectural entities. The focus of this thesis is on step A-E.

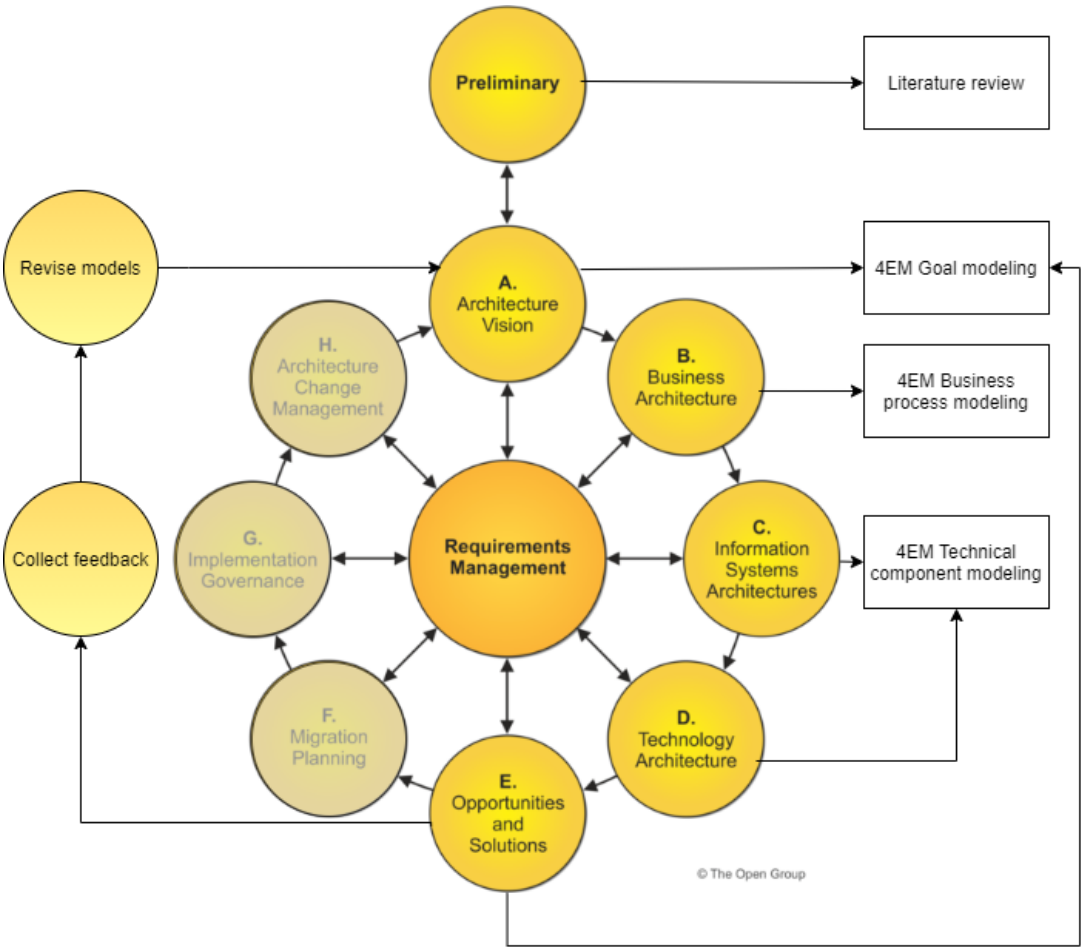

Figure 3.1: The TOGAF architectural development model and how each phase was addressed

The goal of the preliminary phase is to prepare the activities of the ADM by establishing an understanding of the enterprise and its environment, as well as key drivers and goals in organizational context and architectural requirements. It is also important to establish the enterprise's needs for conducting an enterprise architecture and the scope in which it will be conducted. This is also where the enterprise should plan the governance of the architectural work to come. For this thesis, this was done through a literature review which will be elaborated upon in subsection 3.2.

The next step is to identify the architectural vision by establishing the enterprise's goals, drivers and motivation as well as the stakeholders and their concerns. The latter entails identifying

the actors who have interests closely affected by the problems being addressed. The output of this step is a set of high-level guidelines that serve as a basis for further development in order to ensure that the solutions developed are within the scope of the architecture and align with the enterprise's goals and the priorities of the affected stakeholders. For this thesis, this was done through 4EM goal modeling.

The business architecture describes the processes the enterprise employs to meet its the goals and the preferences of its stakeholders. An essential part of this phase is to identify how the current processes may be inefficient in achieving the goals and identify what changes are needed in order to enable the enterprise to achieve the desired situation where all goals are addressed. This is illustrated through 4EM business process modeling.

The information systems architecture contains the application architecture and the data architecture. The former describes the architecture of the application system and how the data is processed while the latter describes the types of data that the enterprise handles in order to deliver its services. For this step, the location and coordination of data storing and handling must be addressed and relevant technical components must be identified. This is then assessed on how well it can aid in making the business processes efficient and if it creates any barriers or bottlenecks that prevents the enterprise from meeting its goals. If there is, the next step is to identify how it can be improved in order to achieve the desired situation.

The technology architecture addresses the physical infrastructures in place within an enterprise and must be analyzed to see if the current infrastructure can support the desired information systems from the last step. These two steps are both illustrated through 4EM technical component modeling.

The process of identifying how the enterprise currently fails to meet the goals and preferences of its stakeholders, and then identify changes necessary for it to address these challenges is called a gap analysis. By performing a gap analysis, the TOGAF ADM provides a guide for how the enterprise can go from the current sub-optimal situation to a desired situation. A central part of this is identifying opportunities and solutions that can address the problems of the current situation (pahse E), and propose services that address this. For this thesis, the opportunities are presented in the 4EM goal models and the gap analysis is discussed in section 4 and section 5.

After this, the opportunities and possibilities are evaluated with regards to risk, time and value delivered (phase F), resulting in a prioritized list of potential projects (phase G). Lastly, the architecture is modified based on the list produced in the previous step (phase H), before the cycle starts on a new iteration. However, since the last three steps require input directly from stakeholders in the enterprise, which was not available for this project, they were deemed to be out of the scope for the thesis. Instead, the revision of the proposed models was based on feedback that will be elaborated upon in section 7.

3.2 Literature review

As described in section 2, the goal of the literature review was to establish an in-depth understanding of the home health service provision and its current challenges and issues. After this, the main objective was to explore how telehomecare tools could alleviate these challenges with the support of enterprise architecture and enterprise modeling.

The initial literature review described above served as a basis for further research and specified

and narrowed the searches in literature going forward.For search strategy, all searches were done in Google Scholar and the initial search was based on the following search terms:

- Enterprise Architecture
- Enterprise Modeling
- Telehomecare
- Telehealth
- Telemedicine

The next part of the literature review focused on obtaining a more specific knowledge of the relevant topics and consisted of a literature search to extract relevant information. Before the new information could be integrated in the thesis, conflicting information had to be identified and resolved. Since EA is a fairly young field, it is defined in several different ways, and so are many of its entities. Thus, when encountering conflicting information, the strategy was to consult several articles specifically for the definitions that were conflicting. Thus, the perspectives would either align because of additional information, or one would be supported by other literature. Then, the new information was integrated with the existing information before assessing the total body of information for whether or not it was enough to establish a sufficient overview of the relevant theory. If something was unclear the process was repeated with focus on expanding the knowledge from the last search until the information set was complete enough to serve as a solid foundation for further work.

The inclusion criteria for the searches was that all articles had to be academic research papers with high relevance to the research area and research questions posed in the thesis. This included research regarding EA, EM, telehomecare and the digitalization of the health sector, as well as privacy and security. Exceptions for the inclusion criteria were official websites such as documentation for TOGAF, General Data Protection Regulation (GDPR) directives and relevant goals set by organizations like the World's Health Organization (WHO) and the United Nations (UN). Thus, for all statistics, only data from SSB (national statistics bureau), WHO and the UN were used. In addition, relevant educational textbooks on EA, EM and software security and privacy were used for theoretical background.

In addition, all articles used in this paper were primary sources. However, in cases were concepts were unclear in the primary source, secondary sources were used to ensure that none of the concepts were misinterpreted. This was done conservatively through a limited snowball effect, which means that if the concepts were expanded upon in a credible article that would be relevant to this paper, it was explored. The snowball was limited in the sense that it did not remove itself more than once from the articles found in the initial search. It is important to stress that the secondary sources were used solely as educational supporting literature and the information extracted from them were not used directly in this paper.
Furthermore, only studies in English were explored, with the exception of national guidelines and statistics, which were in Norwegian. If they had an English translation or equivalent, it was chosen over the Norwegian one.
Lastly, to ensure that the information gathered was relevant and up to date, the studies had to be published after 2000.

The search strategy was to first identify studies that could potentially be relevant. Then, the inclusion and exclusion criteria were used to choose a selection of the studies. After this, the

title, abstract and conclusion were analyzed in order to further determine relevance and exclude any studies that does not aid in answering the research questions. Finally, the studies that were left were evaluated based on a full read through. In order to provide full transparency, an overview of the literature that was reviewed, as well as relevant statistics, can be found in Appendix A. In order to not bloat the list, only the studies that made it to the last step were included.

3.3 Limitation

In order to thoroughly analyze the current situation and get a complete overview of the challenges, it requires several elicitation approaches and involvement from decision makers and developers in the enterprise. However, due to the ongoing pandemic, it was challenging to recruit subjects for workshops and interviews. Nonetheless, the development of an EAF is an iterative process and thus the contribution from this thesis will still be a valuable contribution to gain insight into the enterprise and its processes. In addition it provides a good starting point for further development. Thus, the arguments and models proposed in this thesis are still relevant and reasonable, and the insight gained from literature is adequate to answer the research questions and develop a foundation for further work. For future iterations, the findings should be resolved by including other elicitation approaches.

4 Current situation

In this section, the overarching goals explored in subsection 1.1 will be broken down further and thus give an accurate view of the current situation in the provision of home care services. These goals will serve as a motivation for the changes that are needed and provide an understanding of the problems the current state of home health services faces as well as their causes. This will in turn provide opportunities that should be implemented in the proposed architecture of this thesis. It is important to note that problems and opportunities uncovered may fit more than one of the goals, but are then not re-iterated several times in the model. Then, processes relevant to the goals will be examined in order to find inefficiencies or processes that contradicts the goals of the enterprise.

After this, the desired situation will be examined based on the analysis of problems and solutions. The processes will be changed to reflect the desired situation.

As discussed in section 1, the rapidly growing number of elderly in proportion to the workforce causes serious strains on the provision of health services and thus the main goal of treating non-acute and chronic issues is to facilitate treatment in the patient's home. As seen in Figure 4.1, this can be done by better facilitating better home care treatment (goal 2) and by reducing unnecessary hospitalizations (goal 3). In order for this to be possible, the alignment of strategies and decisions throughout the enterprise must be prioritized (goal 4).

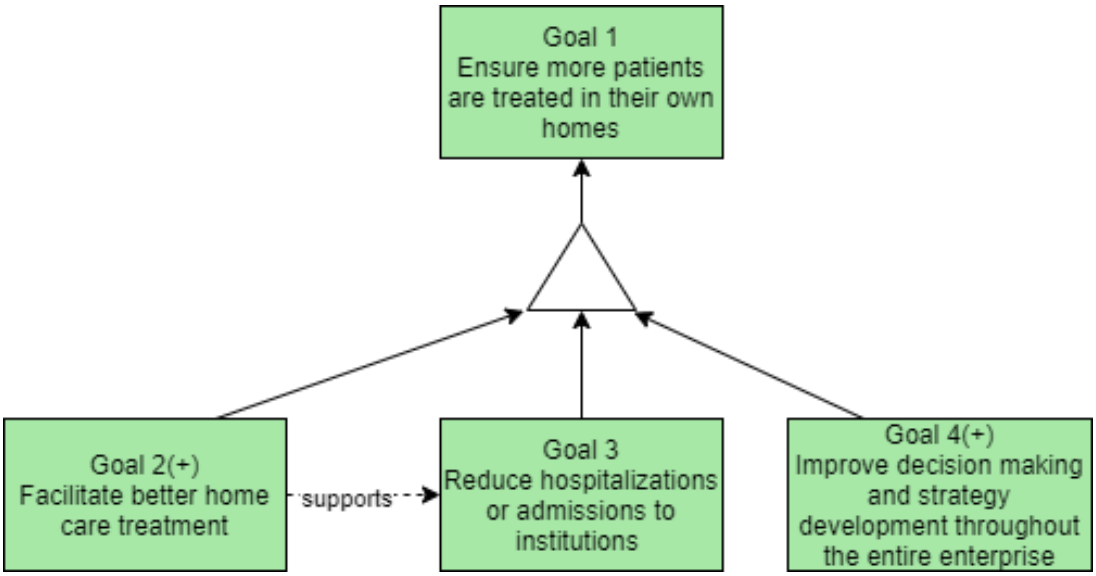

Figure 4.1: An overview of the top level goals in order to facilitate treatment in the patient's home

In order to facilitate better home care treatment, the first, and perhaps most obvious method is to provide better support for patients (goal 2.1). Firstly, in order to treat patients quickly and accurately, the health personnel should be able to access all information relevant to the treatment as fast as possible. In today's situation, most of the information sharing is a one-way street and professionals within the health industry may send information but not retrieve it. This is needlessly time consuming in the rapidly growing digitization of the society and since the current situation paints the home health service provision as strained, the time limit for accessing this information should be drastically reduced. Thus goal 2.1.1 is:

G2.1.1: Get all relevant information about the patient's treatment quickly when it is needed.

As discussed, it could be challenging and time consuming to gather relevant information for the treatment and to illustrate this the process of when a nurse wants to ensure that all information relevant to the treatment of the patient is available is examined. It starts with the nurse arriving at the patient's house in order to initiate appropriate treatment of the patient. If they are certain that all relevant information is available and they are able to quickly consult other health care personnel, they proceed with the treatment. If they are not completely certain, the patient is sent to the hospital in order to take tests. The high-level process of this encounter can be seen in Figure 4.2

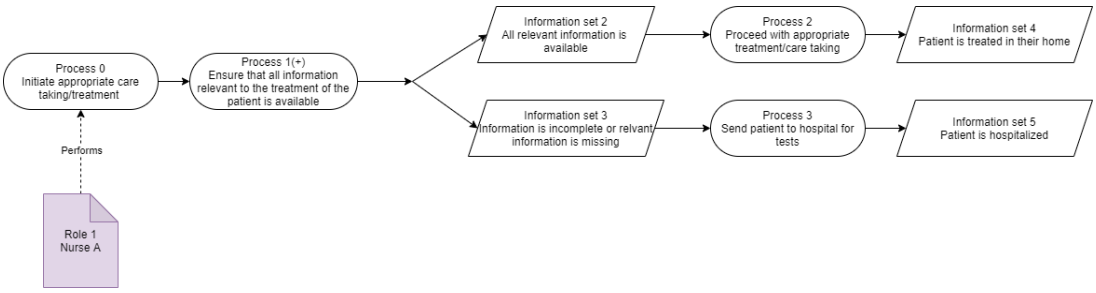

Figure 4.2: The process of a home care nurse initiating the appropriate care taking for a patient in their home

While the steps of this process are necessary and it is important that patients are sent for tests if there is any uncertainty in order to ensure that they are treated correctly, the internal workings of process 1 can be further explored in order to understand the current situation. If the nurse visiting the patient, represented by Nurse A, is uncertain, they can request additional information from other nurses that are involved with the patient, represented by Nurse B. This could be done verbally over the phone if the other nurses are available at the time, or asynchronously by text or by email correspondence upon request if they are not immediately available. In the case of verbal information exchange, there is a risk that information is not complete or that it could be misunderstood. For asynchronous communication, delay in the information exchange is the biggest issue. If nurse A is unable to reach nurse B, or if the information obtained was insufficient, they will have to contact the general practitioner. Thus, the same process as above applies again. If the general practitioner does not have information that could give insight in the patient's condition, they can perform a remote diagnosis. However, since the communication tool they have immediately available is a phone, the diagnosis must happen based on a verbal description. Even if everything goes smoothly, this type of information exchange is time consuming and it may be hard to accurately convey information from both sides of the conversation.

The internal workings of process 1 can be seen in Figure 4.3.

A case study carried out in community care in a Norwegian municipality revealed that the healthcare personnel that were treating elderly in their homes stated that there were many cases where technology could be used to enhance and document their observations in the provision home care services.[16] Without digitization of the documentation, the information gathered is logged analogously and thus it may not be complete or accurate because the information is not documented in the administrative system, but rather at the end of the workday. With the addition of high workload, the administrative duties may receive less attention than the treatment of patients. In addition, the feedback from the focus discussion in section 7 stated

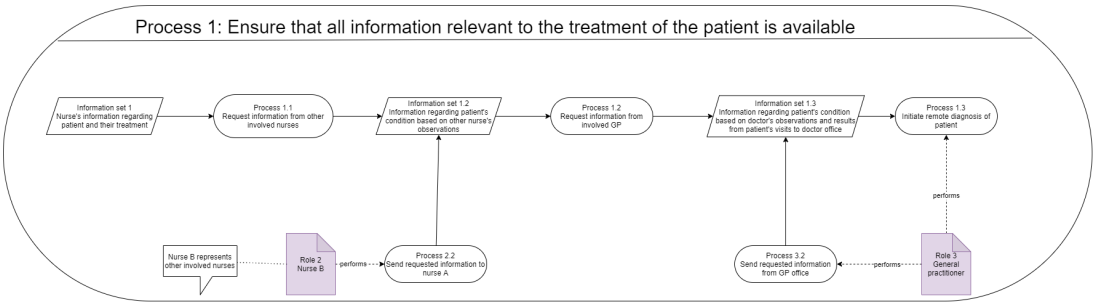

Figure 4.3: The internal workings of the process of ensuring that all information relevant to the treatment

that while the information exchange is often informal or anecdotal, the advice or assessment given often forms the foundation of further treatment. Thus, it requires a high degree of quality assurance and traceability to ensure accountability of the information given. Thus problem 1 and sub-problem 1.1 are:

P1: The information health care personnel have when treating a patient may be incomplete.

P1.1: Informal knowledge exchange lacks traceability and quality assurance

Furthermore, there is a challenge in home care that the healthcare personnel is not necessarily the same every visit. A lack of digitization of the observation and records makes it hard to stay up to date with the patient's state of health and diagnosis. The health care personnel need to access information, and be sure of its reliability in terms of quality and source, in order to ensure consistency in the patient's treatment[75]. At the very least, it could be time consuming for the nurses who then would have to get a verbal handover of information. If the nurse then needs additional information in today's situation, the information can be found in physical journals or internet searches, or they could make a phone call to other health care personnel and inquire for information. Both of these options could be tedious and time consuming when looking for specific types of information such as medications for the patient and so on. If none of these options pan out, the nurse must make an assessment with limited information and if they are uncertain, this could lead to hospitalization or institutionalization. Thus, problem 2 is:

P2: Accessing information is tedious and time consuming for health care personnel.

This could be addressed with the addition of digitized documentation tools that synchronizes the information instantaneously with other involved actors, such as other nurses or administrative department. Furthermore, if the health care personnel were able to access relevant information from other actors, such as the general practitioner, specialists or hospitals, they could be more confident in that the assessment they make have all the necessary information. There is also a need to document what information was extracted and by whom in order to ensure accountability[75]. Additionally, the feedback from the evaluation in section 7 indicated that the need for accountability was important for informal or anecdotal information exchange too. Examples of this could be advice given over the phone etc. This can be conretized into three interrelated opportunities:

O1: Digitalize the documentation of home help services.

O1.1: Implement logging and tracing of all information exchanges

O2: Implement server with information relevant to the treatment of patients that is accessible

to the actors involved with the treatment

In order to make the delivery of home care treatment more efficient and effective, the need for clear and concise information sharing is thus evident. This is also true for when the information sharing is happening directly between actors in real-time while tending to patients. In order to avoid unnecessary trips to a hospital or institution, this communication must be efficient and the patient's condition must be conveyed accurately from the on-site nurse to the person (for instance general practitioner) aiding the nurse remotely. Thus goal 2.1.2 is:

G2.1.2: Establish efficient communication between health care personnel

The current process of obtaining information on a patient is illustrated in **??**. Each of these steps are time consuming and takes away from the time the nurse can spend actively helping the patient. This communication often happens over the phone without the aid of visualization and along with not having access to relevant information about the patient directly, it makes it challenging to convey a clear picture of the patient and their condition. In addition, there is a lack of quality control and accountability when this knowledge exchange primarily takes place over the phone, without any tools for tracing or logging the information. Thus problem 3 is:

P3: Accurately conveying information about a patient and their condition is challenging.

However, this could be addressed by the implementation of telehomecare tools such as sensors and monitoring devices, such as a heart rate monitor, or by having tools for visualization, such as video conferencing etc. Thus, opportunity 3 is:

O3: Implement telehomecare and visualization tools to strengthen the information conveyed in communication between health care personnel

Lastly, in order to provide better support for patients in their homes, the health care personnel needs to spend a sufficient amount of time tending to each patient and ensure that their needs are taken care of. This is also important in order to accurately assess the patient's health and medical condition with a lot of the chronic diseases being hard to diagnose at early stages. Thus goal 2.1.3 is:

G2.1.3: Spend more time tending to patients

However, the job of the home care nurses involves several other aspects such as transportation between homes, administrative tasks etc. While the transportation between homes is challenging to avoid, the implementation of telehomecare tools (O3), could reduce the amount of unnecessary trips by having a clear picture of the patient's well being remotely. Furthermore, nurses reported that administrative tasks, such as logging events and observations into the system, took a long time and lead to less time tending to the needs of the patients. This reveals problem 4:

P4: Limited time in a workday complicates the balance between tending to patients and administrative tasks.

There are several ways to address this problem and by implementing the above mentioned solutions, it would free up time in the hectic life of health care personnel involved with the provision of home care services. However, in order to alleviate the workload of these administrative tasks further, an administrative department, whose main function would be to sort and analyze the observations of the nurses, could be added. Thus opportunity 4 is:

O4: Add administrative department.

An overview of these goals are given in Figure 4.4.

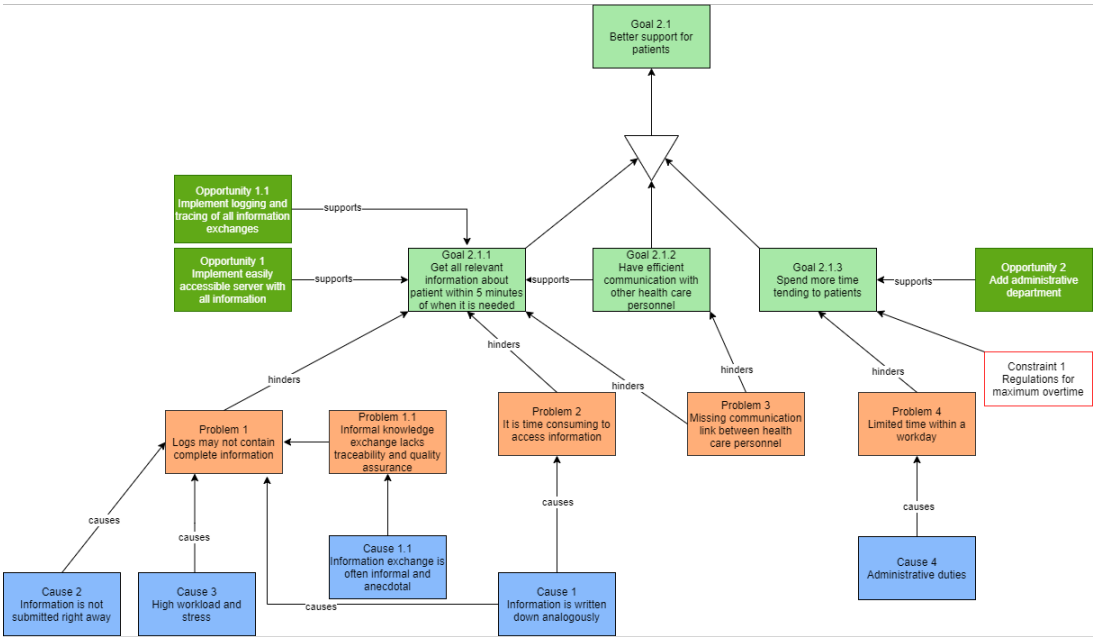

Figure 4.4: An overview of goal 2.1: *Better support for patients*, and corresponding problems and opportunities

As discussed above, one way of facilitating better home care treatment was to improve the support each health care worker could provide for the patients, by looking at the processes and internal communication. Another important, and interrelated, aspect is that there should be enough staff to properly care for all patients. Nurses have reported that there is not enough time in a day to properly tend to all patients and this leads to dissatisfaction with both patients and the nurses who feel that they are not able to do their job they way they would like to. Thus, goal 2.2 is:

G2.2: Ensure that there is enough staff to properly care for all patients.

This can be done in mainly two ways. Either by hiring more home help professionals or by increasing the efficiency of the current number of home health personnel. This leads to two opportunities

O5: Hire more home health professionals

O6: Increase efficiency in the provision of home health service provision.

By increasing the proportion of staff to patients, each health care professional would have more time tending to patients and thus the assumption is that each patient would receive better care. However, as discussed in **??**, the proportion of elderly in need of care is increasing in a much higher degree than the workforce that are eligible to work with home care services. Thus, problem 5 is:

P5: Proportion of elderly to health care workers is increasing.

As mentioned above, there are several issues with increasing the efficiency of home help service providers, with the main takeaway being that the processes in the workday are time consuming.

As shown in Figure 4.2, the process of gathering relevant information, as well as communicating internally, to treat a patient is cumbersome and hinders the efficiency of the home care services, which in turn hinders the goal of having enough staff with time to tend for all the patient's needs. Thus problem 6 and opportunity 6.1 are:

P6: Actors and systems are often disparate.

O6.1: Implement telehomecare tools.

In addition, the actors and systems used are often disparate and there is a lot of relevant data that is not taken into account. There are for instance several third party applications that could be accessed through the patients own devices and that monitor health, for instance daily activity or nutrition, that have no integration with the home care services. These are metrics that could otherwise be hard to track continuously in today's situation. A lot of these services have good usability and easy to use interfaces that enables self management. There is also a lack of internal solutions to monitor these factors and as such, the health care professionals responsible for treatment may miss out on crucial information. Thus, Problem 7 and opportunity 7 are:

P7: Lack of integration from third-party applications can cause health care professionals to miss out on relevant information regarding the patient.

O7: Integrate relevant data from third-party applications

An overview of this can be seen in Figure 4.5

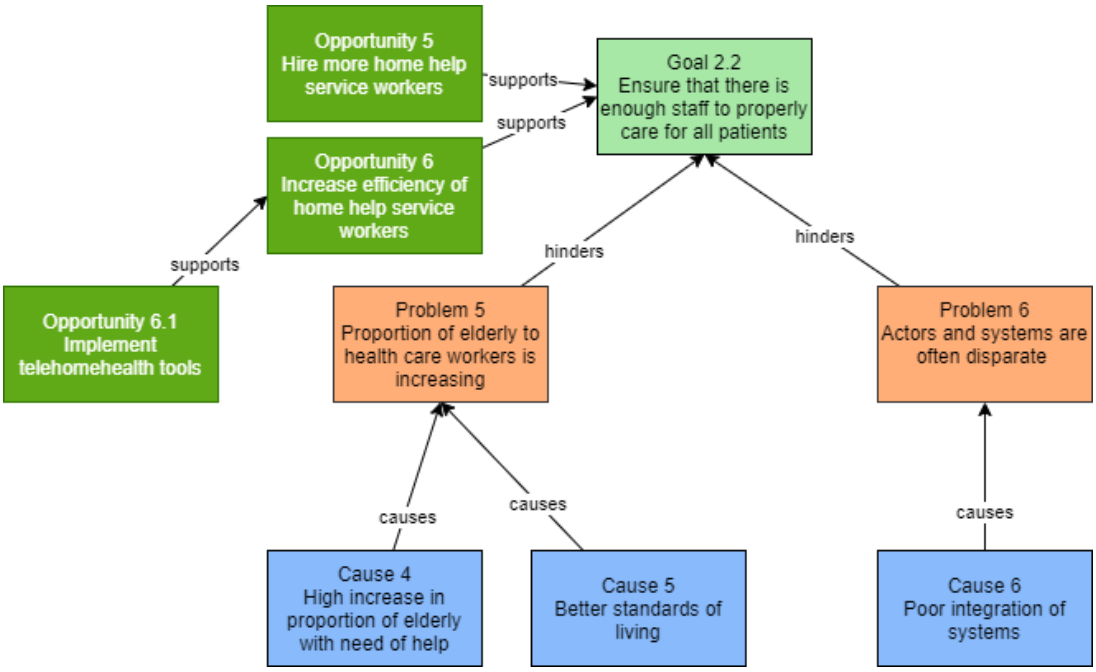

Figure 4.5: An overview of goal 2.2: *Ensure that there is enough staff to properly care for all patients* ,and corresponding problems and opportunities

Lastly, in order to facilitate home care treatment and ensure that a larger proportion of patients are treated within the comfort of their own homes, the patients need at least a certain degree of self management. As discussed above, the health care system faces a lot of stress trying to address the needs of their patients, and while the capacity is relatively stable, the number of

elderly with need for help is steadily increasing. Thus, the home dwelling elderly need to be able to take care of themselves whenever the health care personnel are not available and goal 2.3 is thus:

G2.3: Enable self management for patients

A challenge with the current situation is that home care nurses spend a lot of time doing simple chores that the patient could be able to do themselves with some assistance. This could range from taking out the dishes to being reminded to take medications. By implementing telehomecare tools, the patient could be much more autonomous and self reliant. The assumption is that this would also lead to them feeling safer without the aid and company of the home care professionals and enable them to live fuller lives in their own homes. Thus, goal 2.3.1 is:

G2.3.1: Ensure patients feel safe within their own home

As an additional benefit, this would free up much needed time for the service providers and thus they would have more time to tend to matters related to the patient's health when they come to visit. This would also free up more time for the social aspect of the visit (i.e. conversing with the patient). The telehomecare tools that could alleviate this problem could range from automatic monitoring through sensors to quickly establish the condition of a patient or register a fall, to applications with reminders of tasks like taking medication or integrated smart home solutions to make the daily life of a patient simpler and more accessible. Thus problem 7 and corresponding opportunity 7 are:

P7: Patients require home care nurses for basic tasks.

O7: Provide patient with autonomy through telehomecare tools.

There are several ways telehomecare tools could provide the patient with autonomy. The first is to integrate sensors that could monitor the patient's condition, for instance by tracking heart rate, sleep etc. or by registering if a patient falls. These sensors could continuously monitor the patient's well-being, a feat that is impossible to do manually for the health care professionals. In addition to providing the patients with a feeling of safety, this could enable them to take action if the sensors were to register anomalies. For instance, if a sensor were to register low blood pressure with a patient, they could do something as simple as eat salt and drink water. In addition, the continuous monitoring could provide valuable data to the health care professionals treating the patient and aid in accurate assessment of the patient's condition. Another tool that could be implemented would be application with reminders, such as for taking medication, eating regularly etc. These are tasks that do not necessarily require a health care professional and by integrating this in a patient's home, it could provide the patient with a higher degree of autonomy. Lastly, there are several mundane tasks that get harder with old age, especially if the patient also has health issues. A large portion of these tasks could be performed by the patient themselves with very little assistance. Thus, implementing smart home solutions could enable the patients to be more self-reliant. In addition to freeing up the health professional's time, this would encourage patients to be more active with tasks around the house. This could prove to have health benefits.

O7.1: Integrate automatic monitoring through sensors

O7.2: Integrate applications with reminders

O7.3: Integrate smart home solutions

In addition to ensuring that the home dwelling patient feels safe and comfortable on their own homes, self management also requires them to have insight in their own condition and treatment in order to make informed consent and ensure that the choices they make regarding their health is made with an understanding of their current situation. Thus goal 2.3.2 is:

G2.3.2: Ensure patient has insight in their condition and treatment

In order to feel assured that this is the case, the patients should be able to easily communicate with health care professionals about their condition. And goal 2.3.2.1 is:

G2.3.2.1: Ensure easy communication between patients and health care personnel

In the current situation the most prominent communication tools is a phone, through which it could be hard to convey accurate and reliable information. Thus, if the health care professional in the other end of the phone call is uncertain, the patient is advised to see a doctor. In addition, several elderly have alarms that they can use in the case of an emergency, and with no other easy and accessible way of getting to a health care professional, this could be used in cases where the issue is not critical. The health care professional who receives such an alarm will have to leave the patient they are currently tending to in order to address the alarm. This costs time in travel and reduces the quality of care they are able to deliver to the other patient. This could be addressed by integrating easily accessible communication tools with professionals. This could be as simple as an alarm that could indicate the severity of the issue the patient is facing. Thus problem 8 and opportunity 8 are:

P8: No integrated tools for communication between patients and health care professionals.

O8: Integrate accessible and easy-to-use communication tools between patients and health care personnel

Lastly, in order to ensure that the patient has insight in their condition and treatment, they should have access to their health related data. This means that if they feel uncertain about anything health related, they could simply open an easily accessible interface and get the insight they need. Thus goal 2.3.2.2 is:

G2.3.2.2: Implement easy access to health related data for every patient

In the current situation, most of the information is conveyed through health care professionals. There are some digitization of these data but they are not accessible for elderly who are not technologically savvy. Thus problem 9 and opportunity 9 are:

P9: Patients only get health related data through health care professionals and the digital solutions lack a simple interface

O9: Enable users to access health related data directly through easy-to-use interfaces

An overview of this can be seen in Figure 4.6

In order to alleviate the pressure on the health care sector by ensuring that patients are treated in their own homes for as long as possible, the number of unnecessary hospitalizations and admissions to institutions must be reduced. The first reason for this is simply that the number of free beds at these facilities cannot hold the increasing number of elderly in need of care. Secondly, unnecessary trips to hospitals are time consuming and may cause stress for the patients. Thirdly, the condition of patients are severely reduced after hospitalization. Thus goal 3 is:

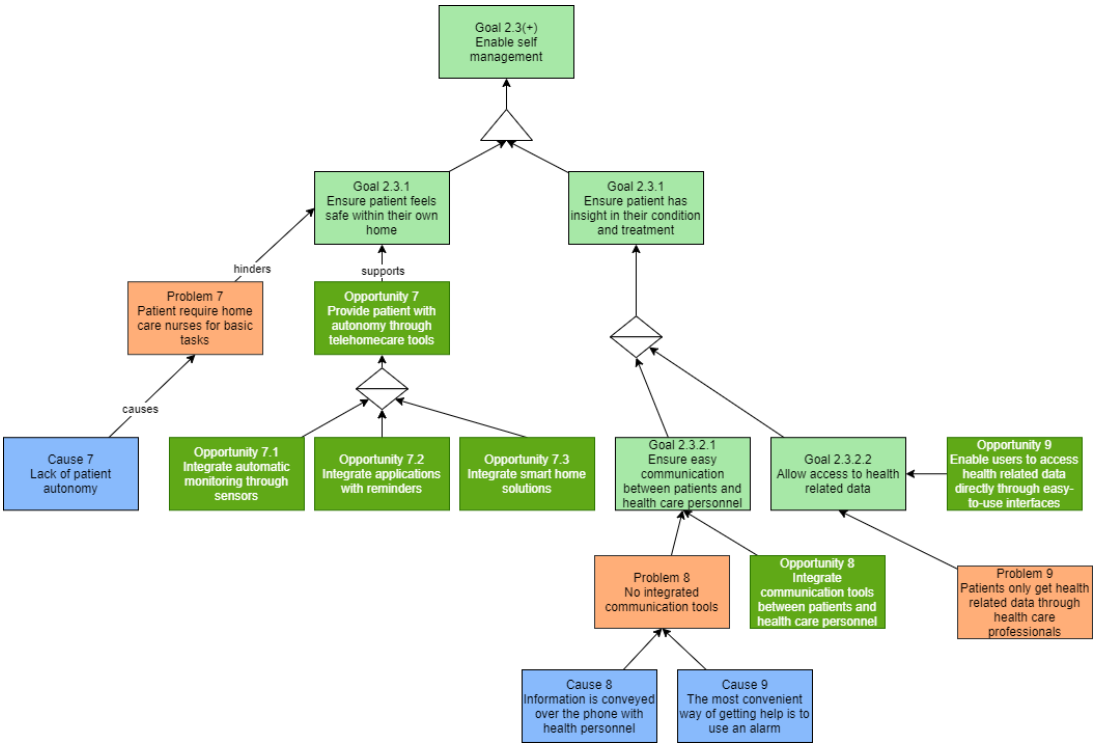

Figure 4.6: An overview of goal 2.3: *Enable self management* ,and corresponding problems and opportunities

G3: Reduce hospitalization and admissions to institutions.

In order to achieve this, the communication within health services must be improved. This will foster more certainty in the diagnosis of the patient and ensure that each involved actor's decision making is based on as much relevant information as possible. The different actors treating a patient are currently working with disparate sets of information and thus building a comprehensive understanding of the patient's medical condition is challenging. By enhancing the communication and coordination between health care professionals, this problem could be mitigated and the patient could be treated in a more holistic manner. This would also ensure that only severe cases gets hospitalized or institutionalized and alleviate the capacity of the health sector and reduce stressful experiences for the patients. These problems and their corresponding opportunities are closely interrelated with what has already been discussed in the sub-goals of goal 2 and will therefore not be re-iterated here. Instead, goal 2 and its sub goals will support the achievement of goal 3.

There will be cases where hospitalization is inevitable and in these cases the most important thing is to ensure that the patient receives treatment that is as optimal as possible and that it is based on as much relevant information as possible. In order to achieve this, there needs to be a continuity between the home health services and treatment at the hospital. However, Danielsen et al. did a series of interviews with home care service providers, including nurses and general practitioners, that revealed a lack of continuity of care between hospitals and the primary health sector [8]. Namely that the general practitioners were rarely involved with the patient's treatment and subsequent discharge from hospital despite having in-depth knowledge of the patient. This lead to a perceived disconnect between the general practitioner and the treatment and left them concerned with the patient's safety since their insight in the patient's

medical situation could provide useful input to the treatment. Another concern the general practitioner had regarding the disconnect was that since the patient had to interact with many different people at the hospital and could often find it confusing to understand what the treatment that was suggested to them contained. In turn, this could provide a challenge it that a patient could give consent without understanding the treatment fully. This is especially true if they receive contradictory information from the hospital and their general practitioner due to poor communication between the latter two. Another consequence could be that since they do not fully understand the treatment, they postpone it or feel unsafe and both general practitioners and nurses stated that they had to function as a translator between the hospital and the patient.

The lack of clear communication was further stressed by the home care nurses. Whenever they were to receive information about a patient's discharge, they could not retrieve it themselves. Instead, the information was sent to the municipality's health care service management who then had to forward this information if requested. This could lead to substantial delays in the distribution and access to relevant information which in turn could lead to uncertainty about diagnosis and unnecessary hospitalizations or premature institutionalization.

Furthermore, the solutions, tests and treatments that are initiated by either the hospital or the general practitioner and home care nurses are not directly accessible for the other actor. This means that the same problem has to be solved several times and perhaps in different ways. This means a lot of duplicated work and effort and if the problem is solved optimally one place, the other place do not have knowledge of it and try to reinvent the wheel. Furthermore, the patients will have a less consistent treatment and may feel a lack of transparency as a result. There is also a risk that some solutions or treatments the patients encounter have already been tested (and failed) or that they are sub-optimal as a result of not having access to all relevant information. This could limit the productivity value of the treatment and cause more work and thus increase the strain on an already stretched health care system.

This could be concretized into one problem with three sub-problems that hinders the provision of care and patient safety, and thus the transition to a home care based health care system, namely:

P10: Lack of continuity between home health services and hospital treatment.

P10.1: Missing information could hinder the diagnosis of patients and subsequently the provision of holistic care.

P10.2: Lack of dialogue and coordination makes patients feel less safe and possibly postpone treatment.

P10.3: Confusion surrounding treatment could hinder informed consent.

P10.4 : Lack of coordination leads to duplication of efforts as several stakeholders within the enterprise endeavor to solve the same issues.

The above-mentioned process is illustrated in Figure 4.7. Here, the patient arrives at the hospital and the medical professionals examine them in order to establish a diagnosis. Then, they decide whether or not the patient needs to be admitted to the hospital for treatment. If the patient is admitted, they have to run additional tests before discharging the patient. Regardless of whether or not they were admitted, a medical report is produced and sent to the municipality health management administration. If the home care personnel or general

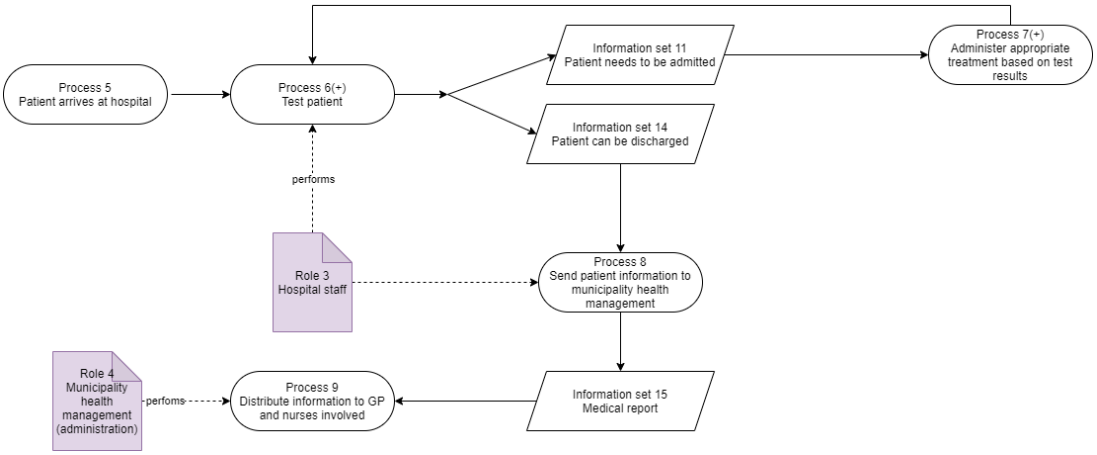

Figure 4.7: The process of treating and reporting on a patient's treatment after they arrive to the hospital

practitioner wants the information the municipality may send it upon request. This could cause a delay in when the home care personnel receive the information and if the patients were to be discharged on a Friday, the information might not reach the nurses attending to the patient after the discharge before Monday the next week.

In order to address this, the nurses and general practitioner interviewed urged for a better, two way communication to replace the current one way communication that consisted of a final medical report. This would enable the general practitioner to have a more central role in the treatment and since the patient is more familiar with the general practitioner this could alleviate some stress around the treatment. This would also increase the likelihood that the information the treatment is based on would be complete since the general practitioner has more intimate knowledge of the patient and their habits, life style and general health condition. Thus opportunity 10 is:

O10: Establish two-way communication between home care professionals and hospital in order to foster continuity in patient care.

Another important aspect of the home care services, and health care in general, is that it is not enough to solely develop exiting technologies, but also to understand how these technologies should be used. According to an advisor to Danielsen et al.'s case, the lack of standards and the amount of disparate systems hinders the integration of solutions. Each general practitioner, nursing home and clinic have their own computer systems and this lack of data infrastructure leads to dysfunctional solutions. According to the home help nurses, the lack of properly functioning technological solutions were both frustrating and time consuming and made it challenging to understand the reasoning behind the guidelines they received. Thus goal 4 is:

G4: Improve decision making and strategy development throughout the entire enterprise

By adding several disparate solutions without having the same set of guidelines for everyone, the solutions will have poor coordination and may not function as intended. Furthermore, if solutions are developed without taking the context surrounding the technologies, such as the social framework and the stakeholders involved, into account, the solution may solve the problem on paper, but fail when implemented into the enterprise. An example of this could for instance be to not take the patients' technological capabilities into account when developing a solution or to ignore the capacities of the health care workers in terms of time or other

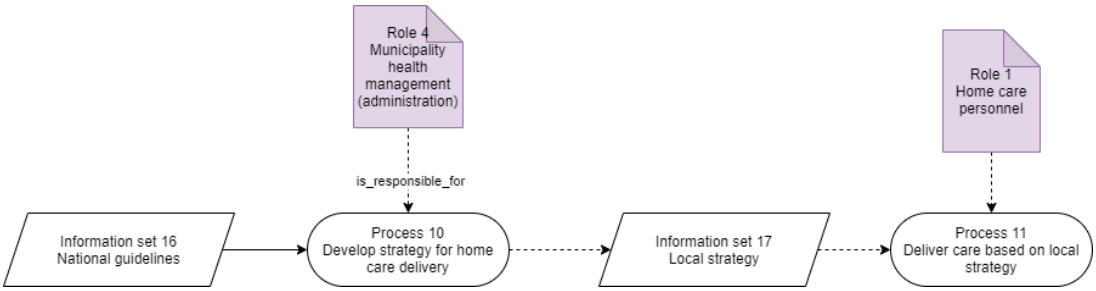

Figure 4.8: The process of developing local strategies based on the national guidelines

resources[11]. The latter could for instance result in home care nurses having to deal with a lot of administrative things such as troubleshooting technology or paperwork instead of providing aid to the patients. It would not be possible to do both as time is already stretched thin for a lot of health care personnel. Thus, this could lead to the health care personnel not having the time to use the new technological solutions and thus lead to them partly or completely abandoning them. This could in turn explain the high rate of failure in the digitization of the health sector. This reveals a problem and an opportunity to solve this is:

P11: A lack of attention to capabilities and the environment surrounding the stakeholders when developing solutions result in high failure rates

O11: Ensure that the capabilities and the environment surrounding stakeholders is taken into account

In order to keep job-satisfaction, quality of work and motivation high, it is important that the home care service providers could communicate with or receive help from co-workers, other health care providers, and managers when required.

Enabling the home care service providers with tools for efficient communication with other health care providers or managers when required, ensures that motivation, and in turn quality of work, stays high[11]. This includes the ability to provide feedback on issues and strategies regarding the provision of home health services. It is also important to enable all actors to engage in knowledge exchange with other relevant actors. This is further emphasized in that a lack of communication regarding challenges or technical problem solving could lead to a high staff turnover, which in turn can result in higher costs and lower proficiency with the systems throughout. The current process of developing strategies is fairly linear and can be seen in Figure 4.8.

As seen in the figure, the current process does not take feedback from the home care professionals that are dealing directly with patients. If they are unable to relay observations and issues they encounter, it will become less motivating to adhere to the guidelines that are implemented. In addition, the decision makers inevitably miss central observations and insights from the personnel that are dealing directly with the patients. Thus, the decisions made are not based on all available information and may as a result be sub-optimal compared to decisions made with basis in all available knowledge. Thus, problem and corresponding opportunity:

P12: Lack of support for feedback from relevant stakeholders results in lower motivation and sub-optimal decision making

O12: Involve relevant stakeholders in decision making and strategy development to foster transparency in decision making.

One way of involving the home care personnel in the decision making is to enable them to provide the decision makers with direct feedback. However, this could potentially lead to a lot of duplication of feedback and would cause a lot of work for the decision makers to go through. Thus, another option is to let the feedback go through the administrative department (Opportunity 4) who can then collect the information and then send feedback to the decision makers. Another option is to have physical meetings or workshops with relevant stakeholders regularly throughout the year. Here, each relevant stakeholder could be represented and brainstorm ideas. This allows for discussion around the solutions and may foster a greater understanding of decisions made and problems that are encountered. Thus, the propositions from these meetings would be more thorough and detailed and thus more actionable for the decision makers.

O12.1: Enable relevant stakeholders to provide feedback to the decision makers

O12.2: Establish physical workshops where stakeholders can discuss problems and possible solutions

A summary of this can be seen in Figure 4.9

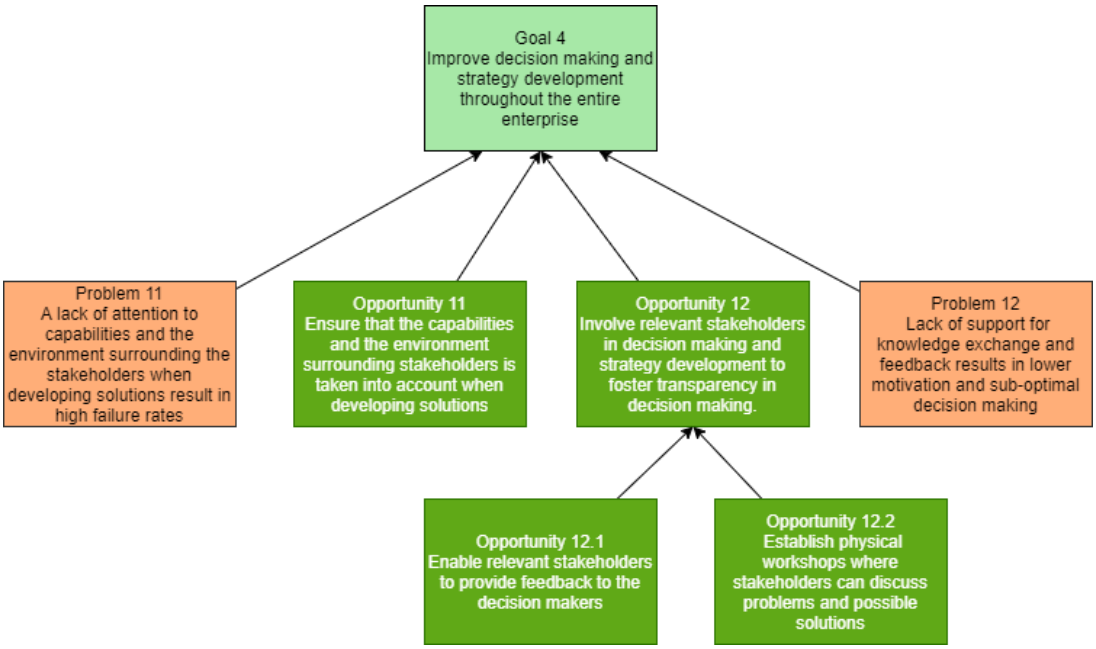

Figure 4.9: An overview of goal 4: *Improve decision making and strategy development throughout the enterprise* ,and corresponding problems and opportunities

In order to ensure semantic interoperability within the enterprise it is crucial that all stakeholders share the same view of similar definitions in connection to the goals and processes. For instance, if one stakeholder understands the concept of telehomecare tools as only sensors and another stakeholder understands it as only monitoring devices, this could create confusion and misunderstandings. If this went unresolved these two stakeholders would work towards different goals and the solutions would be uncoordinated. To address this, 4EM includes a concept model to serve as an enterprise-wide dictionary that contains important things and phenomena that are central in other models. Each concept can have several attributes and relationships with other concepts.

Home care delivery as a concept has several attributes, for instance social contact with the patient, examination, administration of medication and house work, which can include simple tasks such as grocery shopping, preparing food etc. Each of the attributes could be expanded upon as its own concept and it is up to the enterprise to decide how far down the hierarchy they will expand these definitions. For this thesis, the concepts are defined fairly high up the hierarchy.

In addition to the attributes of home care delivery, the concept has relationship to other concepts, such as the health personnel that delivers the home care services or the patient it is delivered to. Each of these also have several attributes that can be seen in Figure 4.10. For the patient, the capability attribute is expanded into its own concept that is based on clinical information (medical history and physical condition) as well as the attribute technical competency. Thus, the fairly broad term 'capability' is clearly defined for everyone involved.

In time, each attribute and concept should be expanded until exhaustion in order to ensure that stakeholders throughout the enterprise define and understand the concepts in the same way. Figure 4.10 illustrates how the capabilities are interconnected and their relationships, but the concepts should also be linked to the relevant processes, goals and actors. this is illustrated for goal 2.1 in Figure 4.11. This will be done systematically for each goal and process in section 5.

The complete overview of the goals, problems and opportunities in the current situation can be seen in Figure 4.12

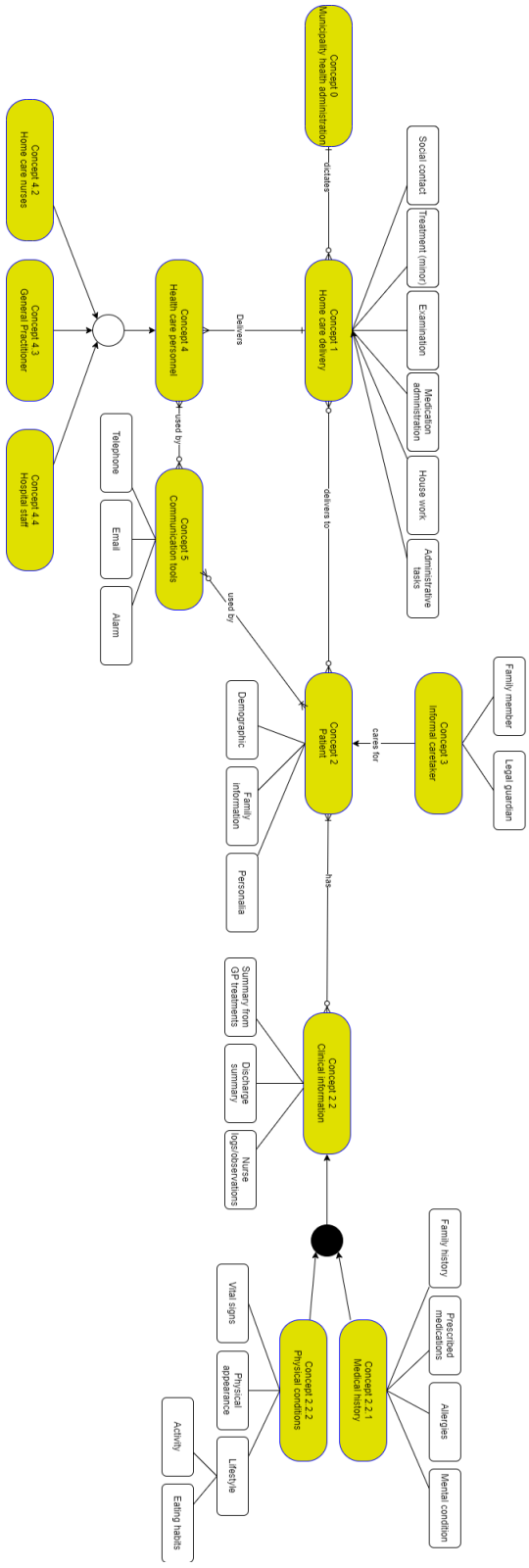

Figure 4.10: An overview of how the relevant concepts are interconnected

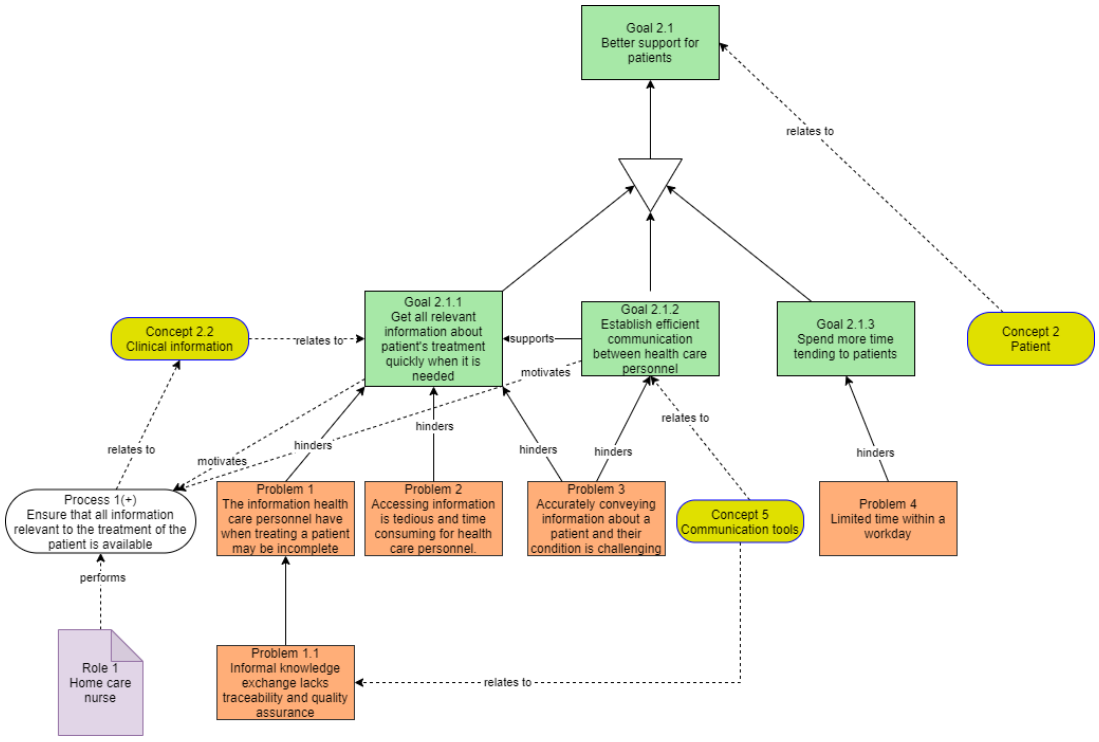

Figure 4.11: An overview of how the relevant top-level concepts relates to processes and goals of the enterprise

Figure 4.12: An overview of all the goals of the current situation and corresponding problems and opportunities that drive the change in the enterprise

5 Desired situation

For the desired situation, each goal will be expanded and possible conflicts between the goals will be resolved. The result of this process is not static and should be treated as a vision for future design that can change as the enterprise evolves. Nevertheless, the desired goal state is based on the problems in the current state and the corresponding opportunities that can be used in order to solve them and will thus reveal possible solutions in the digitization process of the home help services.

The first step of obtaining the desired situation was to refine the goals into a clear multilevel hierarchical structure with high-level goals that can be achieved through combinations of more concise sub-goals. This process entails looking at the goals from the current situation and exploring which opportunities fit as new sub-goals as well as how these can be achieved. This also includes examining the existing models for imprecise phrasing and redundancy, and thus it can be simplified further by addressing this. While the high-level goals can address big issues and thus be unspecific in formulation, the sub-goals are thought to be more actionable goals and thus it is advantageous to ensure that they are concise and specific.

In addition, the correlation, both positive and negative, between goals must be identified. A positive correlation implies that achieving one goal will support in achieving another, while negative correlation might hinder the achievement of goals. Thus, possible conflicts between the goals must be identified and managed properly in order to avoid confusion and unobtainable goal states. This entails proper prioritization of goals in the case where it is impossible to achieve both goals simultaneously so that the least important goal can be dropped. Lastly, the opportunities explored from the current situation serve as goals for the desired situation.

By looking at the goal state in Figure 4.12, the first factor to take into account is redundancy in the model. The first redundancy that is evident is goal 3. It has no sub goals and is supported by goal 2 and its sub-goals. This means that if goal 2 is achieved, goal 3 will almost inevitably follow. So even though goal 3 is still a desired outcome for the home health service enterprise, it does not need to be explicitly written as a goal.

Another redundancy that becomes apparent after inspecting the current model is communication. It is repeated throughout the model and refers to both communication between health personnel and from health personnel to patients. Thus, it is beneficial to gather them under one high-level goal, and a new goal replacing the old goal 3 is *G3: Improve communication between stakeholders in the home help services* The entities that are related to this goal are G2.3.2.1, G2.1.2, O1, O1.1, O3, O8 and O11 and thus the hierarchy of goal 3 can be seen in Figure 5.1.

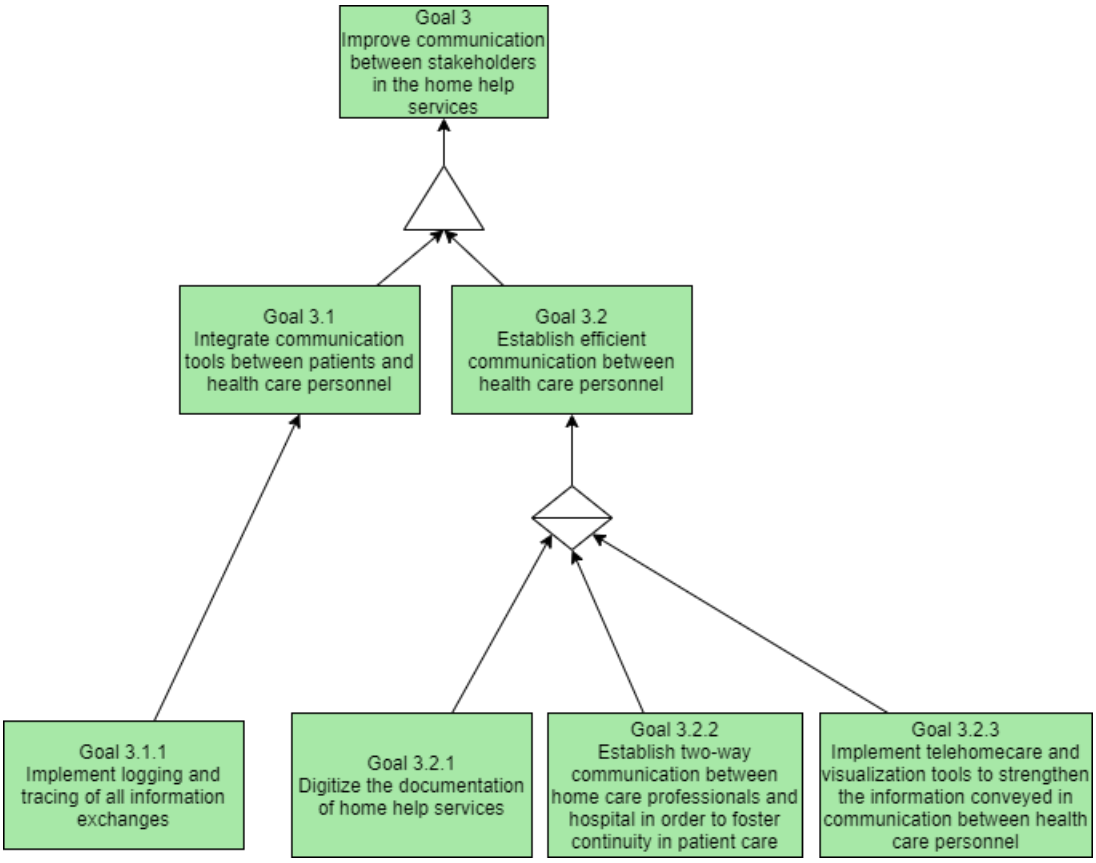

Figure 5.1: An overview of the added goal 3: *Improve communication between stakeholders*

Furthermore, the formulation of goal 2.1 *Provide better support for patients* is not very specific and after moving G2.1.2, the remaining sub-goals are both about tending to a patient as quickly as possible. Furthermore, opportunity 2 is very specific compared to goal 2.1.1 and since the latter does not have any other related entities, they cause redundancy in the model. Thus, goal 2.1.3 is transformed into goal 2.1 with opportunity 2 and 4 serving as its sub-goals.

For goal 2.2, opportunity 6 is addressed by the addition of goal 5 and the sub-goals of goal 2.3. Thus, it is removed along with its sub-opportunity. This leaves only one sub-goal and thus opportunity 5 is transformed into goal 2.2. However, the methods and means for increased recruitment of home care personnel is out of scope for this thesis and thus it will not be elaborated upon. Therefore, it will be marked in red instead of green.

By moving G2.3.2.1 to the hierarchy of goal 5, goal 2.3.2 has only one sub-goal, which in turn has only one opportunity. Thus, opportunity 9 is transformed into goal 2.3.2. For 2.3.1, the phrasing is not specific and while patient safety will be a priority and a result of the changes made, it should be changed. Thus, opportunity 7 is transformed into goal 2.3.1. All these changes can be seen in Figure 5.2.

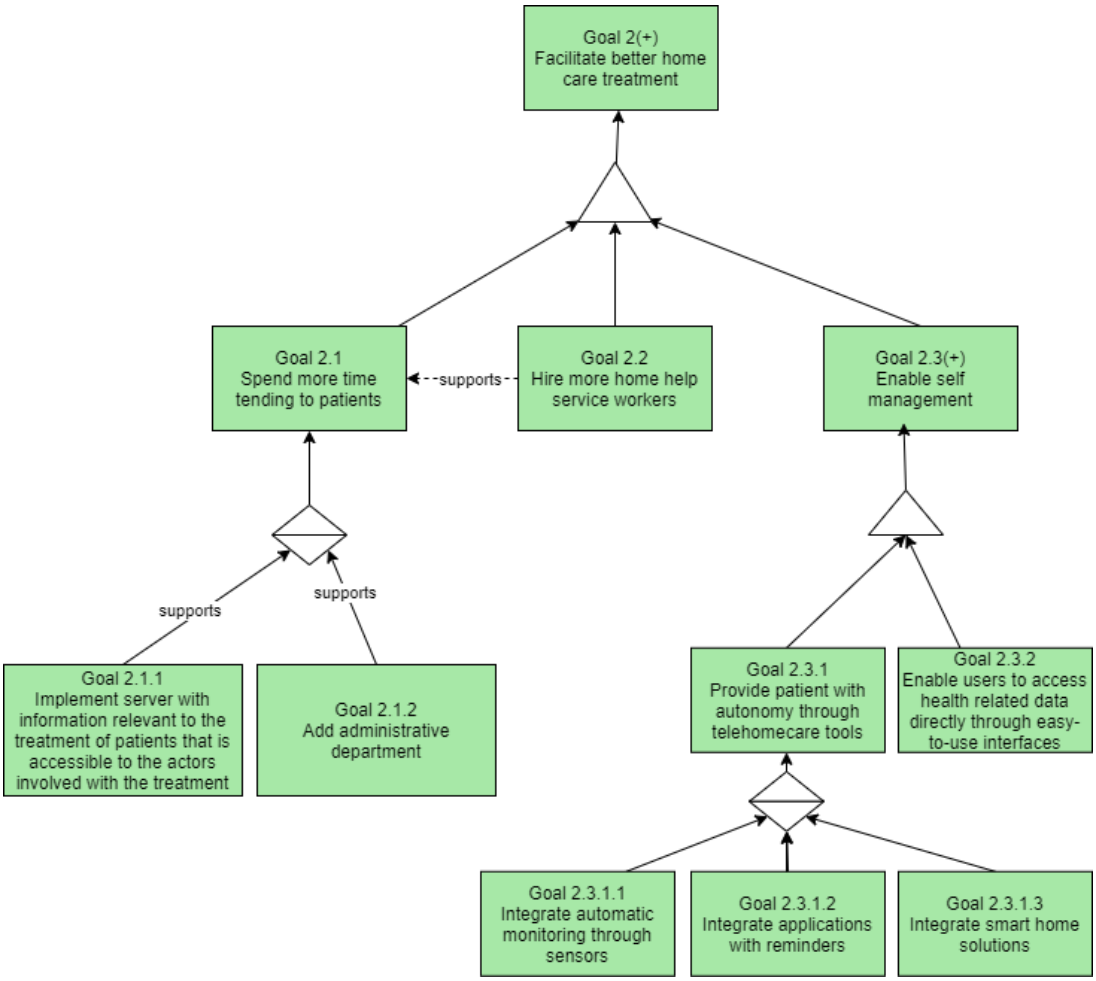

Figure 5.2: An overview of the modified goal 2: *Facilitate better home care treatment*

For goal 4, there are no conflicts and thus the only change is that opportunities are transformed to goals, as seen in Figure 5.3

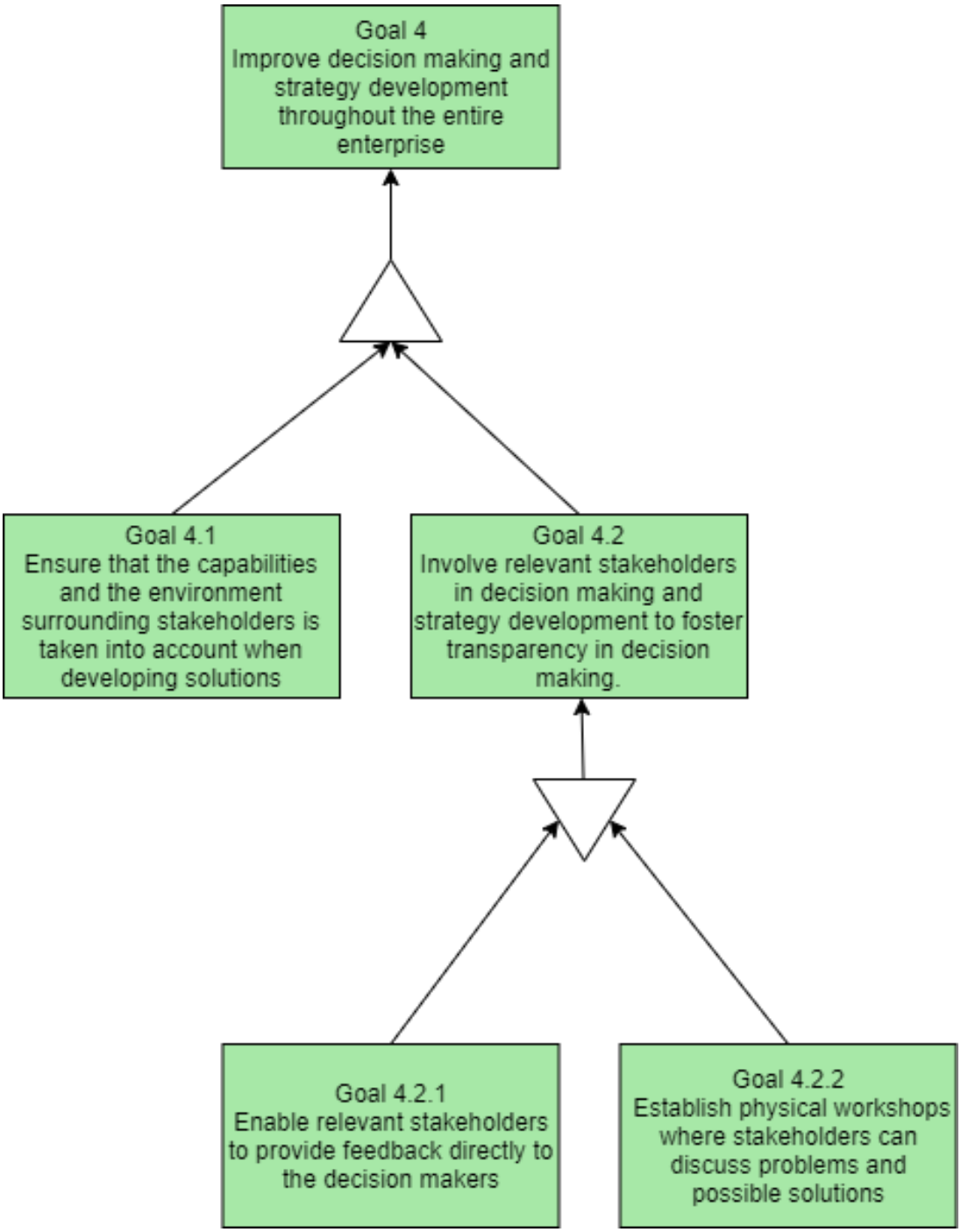

Figure 5.3: An overview of goal 4: *Improve decision making and strategy development throughout the entire enterprise*

In order to ensure semantic interoperability, concepts that are introduced in the new models must be addressed in order to avoid confusion when trying to achieve a goal. Firstly, "capability" is a rather broad term and thus it is important to have an enterprise-wide definition of this term. For this thesis the patients' capabilities are distinguished from the health care personnel's capabilities. For patients, the capabilities are reliant on the physical and mental condition as well as their technological competency. In addition, their clinical information

and the environment surrounding them will also affect what the patient is capable of. The environment is described as the physical environment, such as urban or rural living, family dynamics and available technology. The latter could for instance be whether the patient has a smart phone for health applications or not. For the health care personnel, the most important factors to determine capability are their technical competency, experience and workload. When developing new solutions it is important to have these factors in mind, because they are the ones using the solutions and if they do not adopt the new technologies, for instance if they take too long to learn or are time consuming to use, the health care personnel might return to old routines and technologies. Thus, if the capabilities of the health care personnel is not taken into account, the uptake of new solutions will be slow and thus failure rates will be high. The added capability concepts can be seen in Figure 5.4.

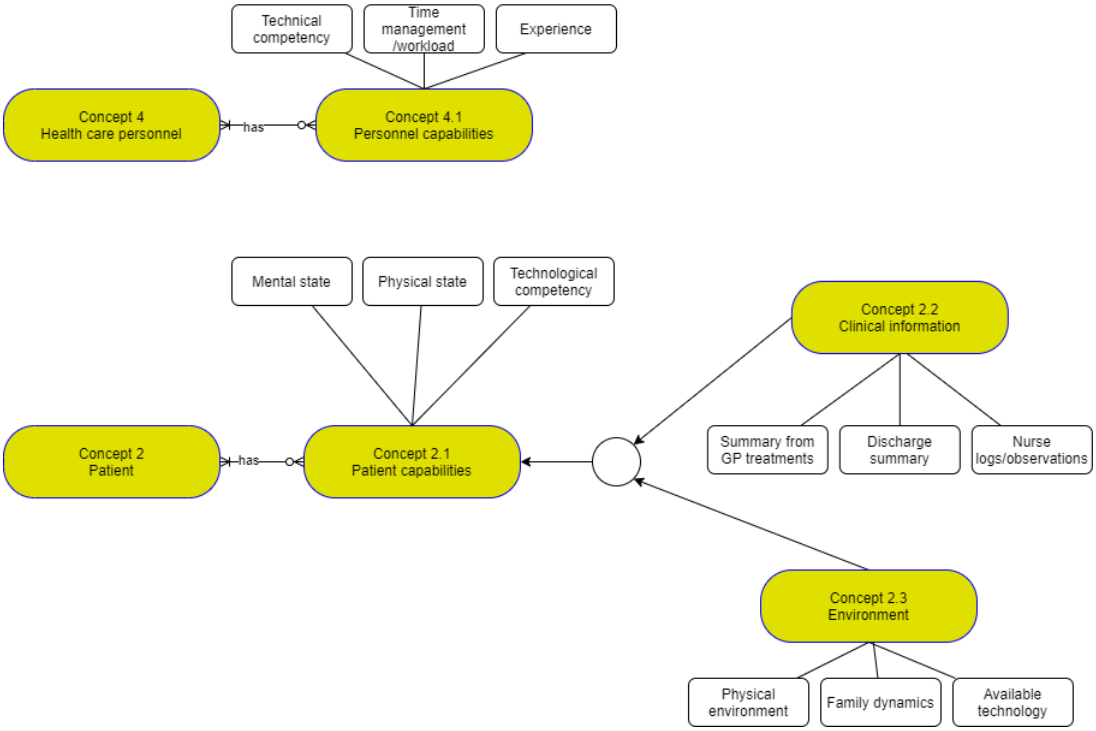

Figure 5.4: The added concepts of stakeholder capabilities and their closest neighbour nodes

The next concept that must be addressed is telehomecare tools, which consists of sensors, reminders, smart home solutions and communication tools. Thus, communication tools is moved to be a child of the telehomecare tools node. Each attribute can be expanded as its own concept when the solutions are being developed. Sensors could for instance refer to several different monitoring tools, such as for pulse or blood pressure, or to register the fall of a patient and this should be specified as attributes to the sensor concept in further development of the concept model. The communication tools concept is expanded to include visualization tools as its child and the latter consist of video link, image sharing and a shared whiteboard where the involved health care professionals can use illustrations to better convey information.

The concepts relating to security measures necessary to maintain privacy and data security are also added. These will be discussed in subsubsection 6.2.2.

Lastly, the health care personnel node is expanded with an additional child, namely the admin-

istrative department. Although this addition does not remove administrative duties entirely for the home care nurses, it considerably reduces this kind of work and thus the "administrative tasks" attribute is removed from the home care delivery concept. The expanded concept model can be seen in Figure 5.5

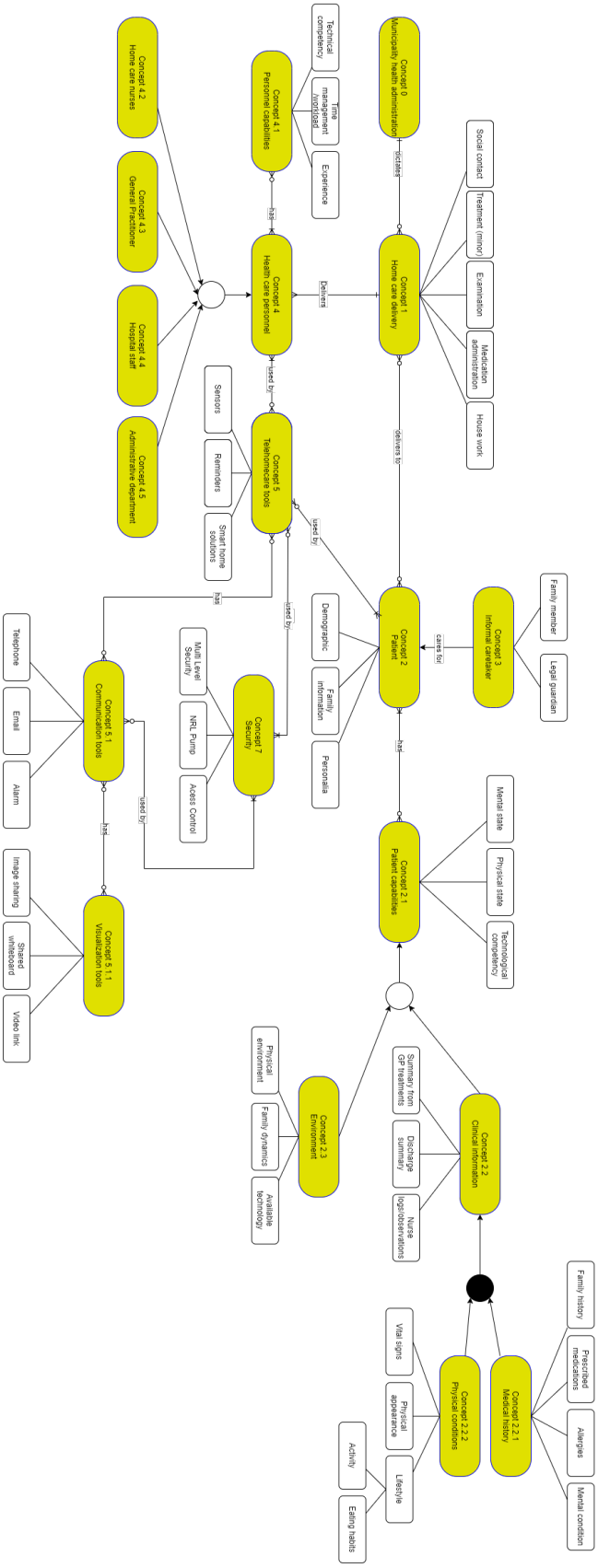

Figure 5.5: An overview of all high-level concepts in the desired situation and their relationships

The process a nurse has to go through in order to obtain information, as seen in Figure 4.2, does not have to be modified at the highest level since it is correct to hospitalize patients if there is uncertainty in the diagnosis. However, it can be beneficial to examine the internal workings of process 1 in the perspective of the new goal models. Goal 2.1.1 states that in order to enable home care professionals to spend more time tending to patients, the implementation of a server with information regarding the patient's condition and treatment, and that is accessible for all involved stakeholders, is beneficial. Involved stakeholders that should be able to access and update information on this server are home care professionals, general practitioners and hospital staff, as well as the patient and their caretaker. By implementing such a server, it eliminates the delays in information exchange, and the time consuming process of requesting information and then having it sent, that were present in the current situation. Furthermore, it enables the nurse to instantly access information that could be relevant to the diagnosis or treatment of a patient. Having this information readily available not only saves time that can be spent tending to the patient, but also allows the nurse to more accurately assess the patient's condition. Issues and challenges regarding privacy and security with this solution are discussed in subsubsection 6.2.2.

In addition to accessing the server, the observations made by health care professionals, for instance nurses on home visits or general practitioner after the patient has been to his office, should be digitized (goal 3.2.1) so that it could instantly be uploaded to the server. This could also be the case for third party health applications or telehomecare tools that give continuous monitoring of the patient's condition[1]. All the data could be uploaded directly, but it would be beneficial to send it through the administrative department of goal 2.1.2 to "clean" the format of the information. The implementation of a shared server would thus ensure that the other stakeholders have updated insight in the patient's condition at all times. However, having such a server, especially with third party service providers, requires proper security to ensure that the privacy of the patient is maintained. This will be discussed in subsubsection 6.2.2.

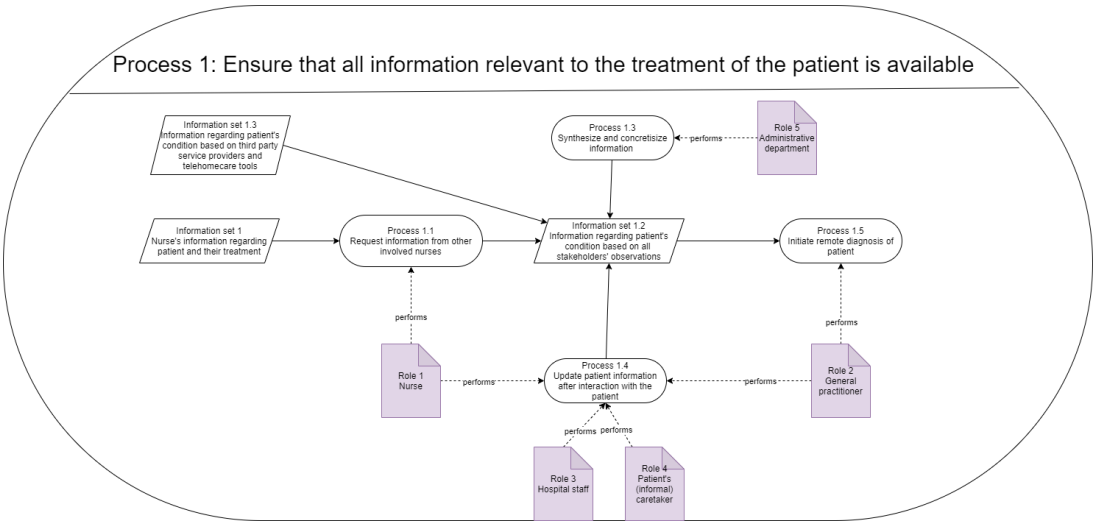

Figure 5.6: The process of ensuring that all relevant information is available for diagnosis or treatment of a patient

[1]This is added as information set 1.3 in the model for the sake of simplifying the model, but will be revisited in the full EAF

In addition to the server, goal 3.2.3 addresses the challenges in conveying information accurately in the communication between the nurse tending to the patient and other health care personnel, such as the general practitioner. By establishing visualization tools, such as a video link or a shared drawing board, it is much easier to accurately describe the patient's condition and thus get help in diagnosis. In the case where the information on the server is not enough, this enhanced communication will aid in preventing premature hospitalization and provide both the nurse visiting and the patient with a feeling of safety. The internal workings of process 1 can be seen in Figure 5.6

It is important to note that even though this process focuses on a home care nurse accessing the information, the process would be similar for all involved stakeholders, including specialists that are involved in the treatment. The information should also be easily accessible for all patients,which addresses goal 2.3.2 and which requires simple interfaces for less technically competent patients or patients with disabilities, such as reduced sight or cognitive functioning.

The shared server will also be beneficial for the treatment of patients at hospitals since this would allow the general practitioner or home care nurses to contribute their observations and advice in the treatment of the patient. This would in turn reduce the amount of duplicated work done and ensure that all relevant information is taken into consideration. In addition, this could reduce the number of tests that need to be taken at the hospital and thus save time for both the staff and the patients. An added benefit is that this would also reduce the stress of not only the patient being treated, but also patients waiting to be treated as they would move up the queue faster. The addition of automatic monitoring through sensors (goal 2.3.1.1) could also provide feedback that could aid the diagnosis of the patient and further reduce the time spent on redundant tests. This could for instance be continuous monitoring of heart rate or blood pressure, which can give indications of the patient's condition over a longer period of time than the tests would be able to cover. If there is any information missing, there should be a two-way communication link between hospital staff and other involved health personnel so that they can discuss the treatment. This would ensure that the health care professionals that know the patient and have followed their condition, and possible deterioration, closely can provide insight in the patient's condition. Ensuring that all information is taken into account and that redundant tests are not taken unnecessarily also has the added benefit of increased patient satisfaction, since repeating and re-testing could be stressful and frustrating to many patients.

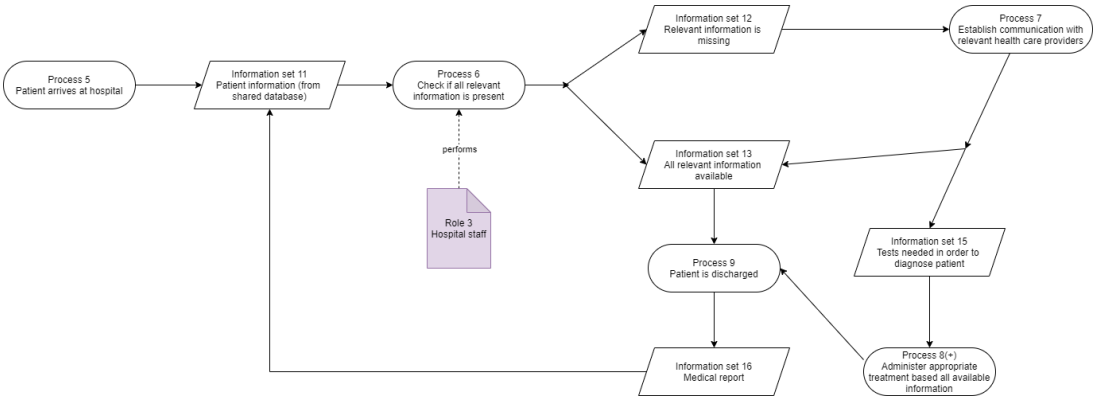

Figure 5.7: The process of diagnosing and treating and reporting on a patient's treatment after they arrive at a hospital

After the test have been administered and the patient is diagnosed and/or treated, the medical report from the hospital can be uploaded directly into the shared database, thus ensuring that the relevant health care professionals instantly have all the relevant information. This would enable them to better accommodate the patient after their discharge and would aid in the continuation of care between the hospital and the patient's home. The process can be seen in Figure 5.7.

In addition to the enhanced communication internally between health care professionals, the digitization of services and implementation of telehomecare tools can aid in the patients' communication with health care providers (goal 3.1). By introducing devices with high focus on usability, the patient's can update information and send it directly to other relevant actors. This could for instance be done through a tablet or be enhanced with telehomecare tools and sensors that could provide the home care professionals with a more coherent overview of the patient's condition. This would enable them to more accurately evaluate the severity of a situation and thus allow them to reassure the patient or their family if the situation is not severe and act quickly if it is. A simple improvement to the current situation could be to allow the patients with alarms to indicate the severity of the issue they encounter. This could enable a nurse who is visiting another patient to respond accordingly, for instance by finishing the current visit if it is not severe and responding right away if it is. This would require continuous feedback to the patient on the status of the nurse in order to ensure that the severity is not exaggerated in order to get help quickly with matter that are not severe. For matters that are not severe and that are related to simple tasks, smart home solutions (goal 2.3.1.3) could alleviate a lot of the home care professional's work load by providing continuous and instant help for these issues. In addition, integrating applications with reminders, for instance on devices the patient already owns or within the smart home solutions, will help further reduce the workload of the home help professionals and thus they can spend more time tending to patients. This could also free up time for increased socialization with the patients, which could in turn increase the well-being of the patients.

The communication throughout the enterprise must also be enhanced in the development of strategies and guidelines. In the current situation, this is a one-way street where the home care professionals who treat the patients do not get insight into the decision making. In addition, providing feedback based on their observations and interactions with patients was challenging. In order to allow for full transparency, the relevant information that serves as a basis for decisions and guidelines should be accessible for everyone it affects. This could for instance be done through a shared server that all relevant actors could access through their devices, which would also allow them to upload their suggestions directly to the server (goal 4.2.1), or perhaps through the administrative department of goal 2.1.2. This would not only foster transparency, but also ensure that ideas that look good on paper could be evaluated by the actors who would use them in practice at an early stage. If the suggested solution is not optimal, they may even provide better solutions based on their experience with patients and home care services. This could save both time and money. The process can be seen in Figure 5.8.

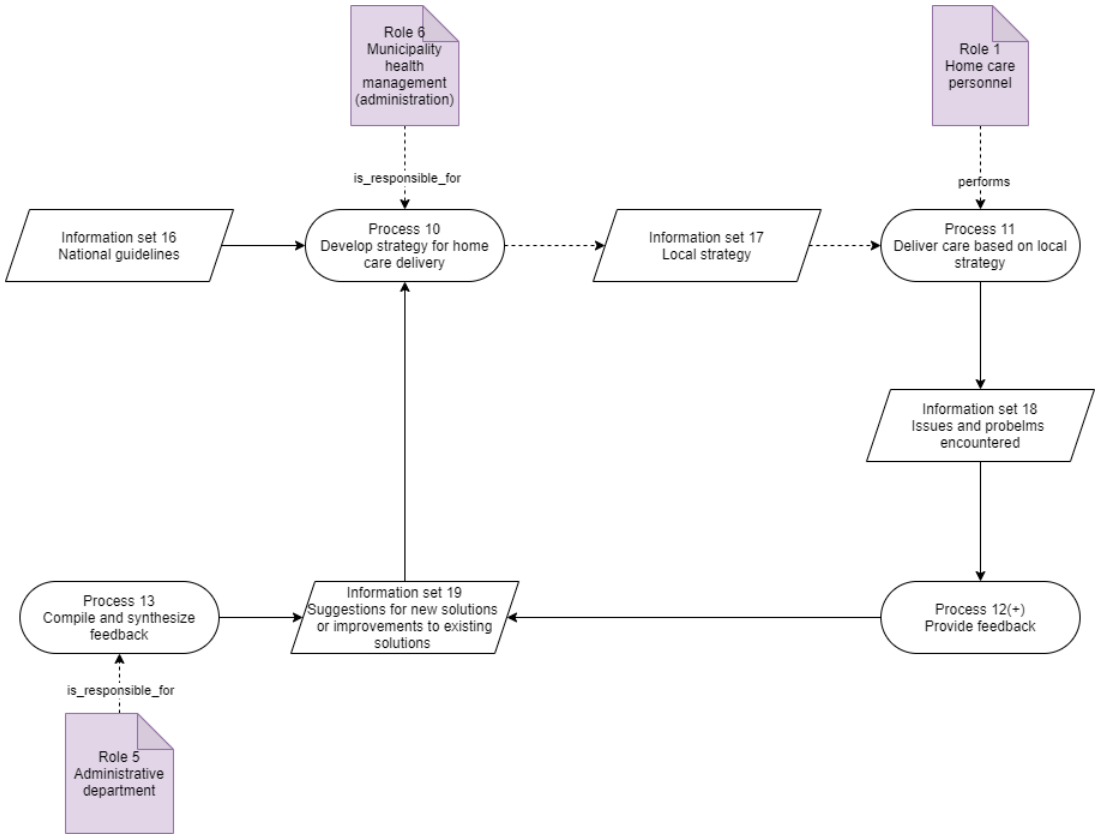

Figure 5.8: The process of developing strategy with transparency and feedback

Another way of obtaining feedback is through periodical physical meetings or workshops where the involved actors could meet and discuss problems they are facing and explore possible solutions. The workshops could have particular goals in mind, or simply be a place for the home care professionals to share the issues they face that they feel are not being taken into consideration when the strategies are being developed. An advantage of having physical workshops is that it leaves more room for an in-depth discussion to foster understanding between the participants. Thus, the home care professionals get more insight in the rationale for the guidelines and the decision makers can get a clearer picture of the issues the home care professionals face.

Compared to the other option of uploading the feedback, the physical workshops foster a more in-depth understanding. However, it also requires more resources and coordination and thus the threshold for providing feedback through devices is much lower. In addition, providing the feedback instantly, as opposed to waiting for a workshop, ensures that the information is detailed and correct and that if the issue needs follow-up, all information is available. In light of these pros and cons, either solution, or a combination of both, would be beneficial for transparency and the alignment of strategy development in the enterprise.

In order to achieve the processes and goals of the desired situation, the technical components of the enterprise must evolve. In the current situation, the systems, solutions and information (servers) are disparate and rarely communicate. In addition, the proportion of elderly in the need of help is increasing too fast for the current way of providing health care to be sustainable and thus a digitization is needed. The first step to achieving this is to integrate shared servers containing all relevant information that could be accessed by any actor involved with the

patient's treatment. Because having all patient information so readily available raises concerns around the patient's privacy, it would be beneficial to implement several servers with a different degree of sensitivity. For instance, one should differentiate between the shared server used for information retrieval by home care nurses and the server used for providing feedback since these are completely different sets of information that do not affect each other. In addition, each health care professional should only have access to information directly relevant to them, so it would be beneficial to implement features such as multi layer security or virtualization of servers. The security of the servers will be explored further in subsubsection 6.2.2.

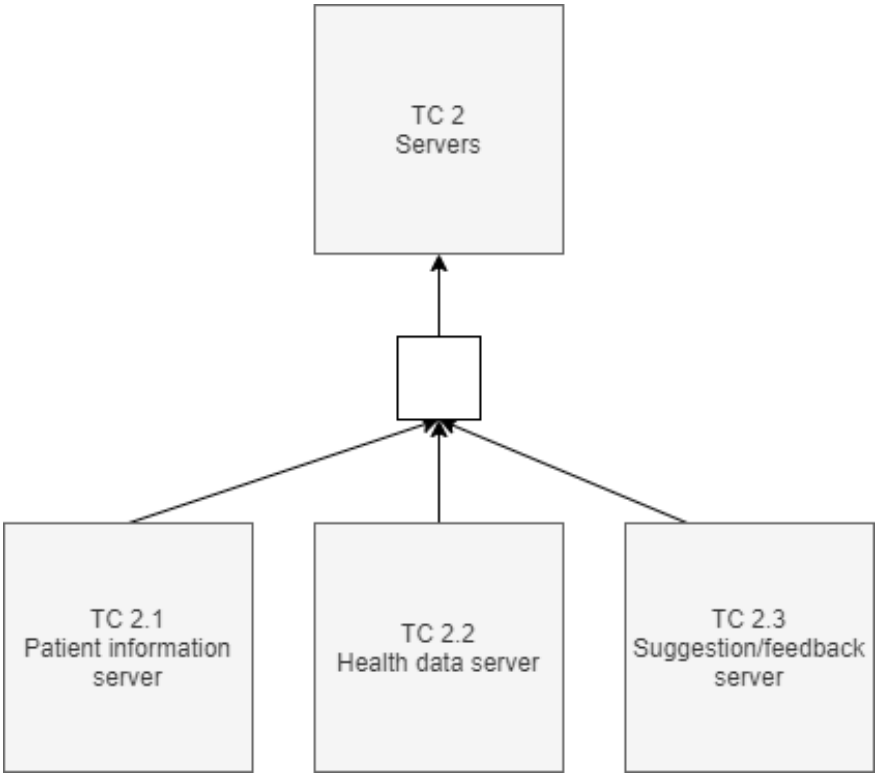

Figure 5.9: The three main servers to support efficient information exchange in the desired situation

As seen in Figure 5.9, this thesis suggests to implement three main servers, namely the patient information server, the health data server and the suggestion/feedback server. The patient information server should contain all information relevant to the treatment of the patient and be accessible for any actor treating the patient. It should be continuously updated with information after visits to the various actors involved in treatment of the patient. The health data server is envisioned to contain all raw data obtained from telehomecare tools, such as sensors monitoring heart rate etc., and should be synthesized and refined before being integrated into the patient information server to provide even more insight in the patient's condition. By having these servers separated, it allows for less privacy concerns when integrating third-party service providers since they will not have access to the sensitive data on the patient information server even if there was a data breach on the health data server. Further measures to ensure security with third-party service providers will be explored in subsubsection 6.2.2.

The technical components can be expanded as far as needed for the enterprise, for instance by providing details on the kind of sensors that are used or the specifics of the visualization tools

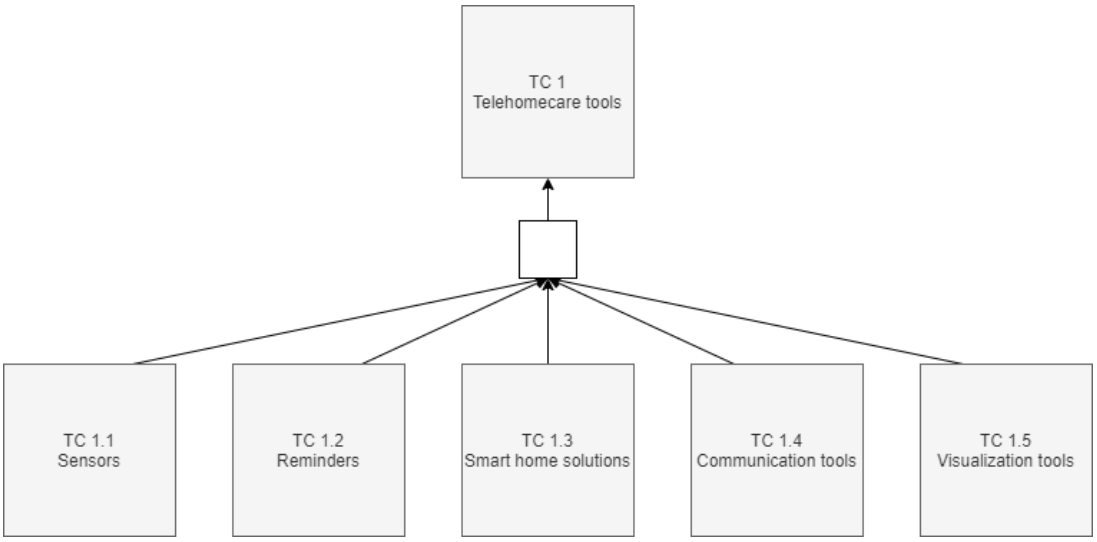

Figure 5.10: An overview of the telehomecare tools that are considered in this thesis

used. This is advantageous to include so that all levels of the hierarchy of the enterprise can get an overview of technologies used. However, for this thesis, a more generalized overview to illustrate the possibilities is used. This was mainly done to improve the readability of the models. An overview of the telehomecare tools that are considered in this thesis can be seen in Figure 5.10.

Lastly, the feedback from the evaluation in section 7 indicated a need for payment systems to facilitate home visits from specialists or the GP. Thus, the technical components needed for this would have to be added. This would include an interface to perform the payment, a separate server with billing information and payment data. The details for this solution and its implications are out of scope for this thesis, but have been outlined in the full overview of the technical components, Figure 5.11, as TC 2.4, TC 6.6 and TC 5.1 in .

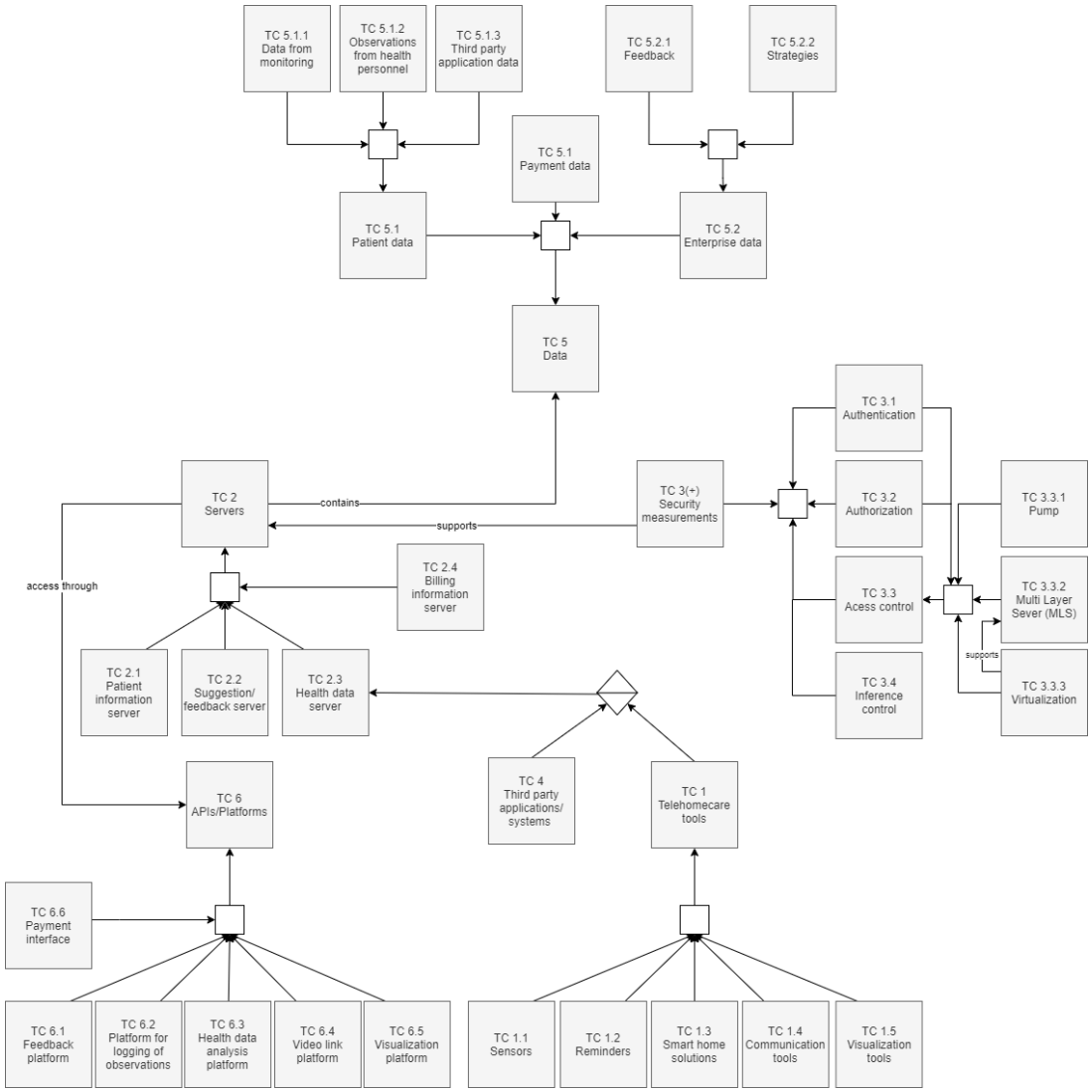

Figure 5.11: An overview of all techincal components that are considered in this thesis as well as how they are interrelated

Finally, combining the components from the models, we get an overview of how they are interrelated in Figure 5.12. For readability, the presentation of the components and their relationships are not exhaustive in this figure.

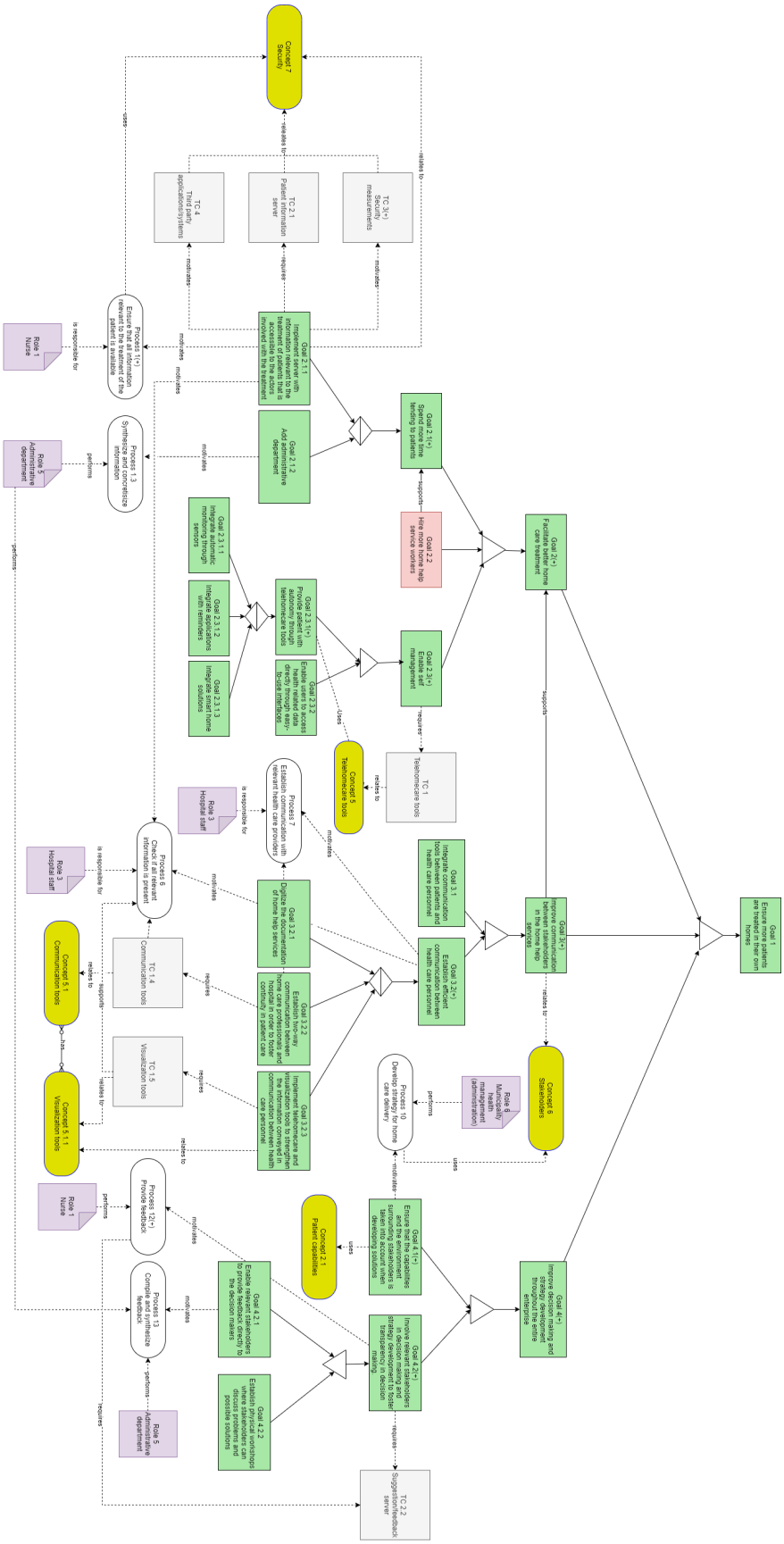

Figure 5.12: An overview of how the components of different models are interrelated

6 Proposed Enterprise Architecture Framework

To enhance the implementation of the entities presented in the models in the previous section, they will be structured through a proposed EAF is presented in this section. The proposed solution is based on the CityXChange architecture in subsection 2.2. However, since the architecture was developed for a smart city environment, it must be adapted to the home health services. Thus, the content of each layer will focus on the same aspects as the CityXChange architecture, but in the context of home help service provision. The proposed architecture can be seen in Figure 6.1. The red layers are added to the architecture, and the orange layers is an expansion of previous layers. In addition, the content of the other layers are modified to fit the home help service enterprise. In this section, each layer will be explained and the changes and adaptations will be explored.

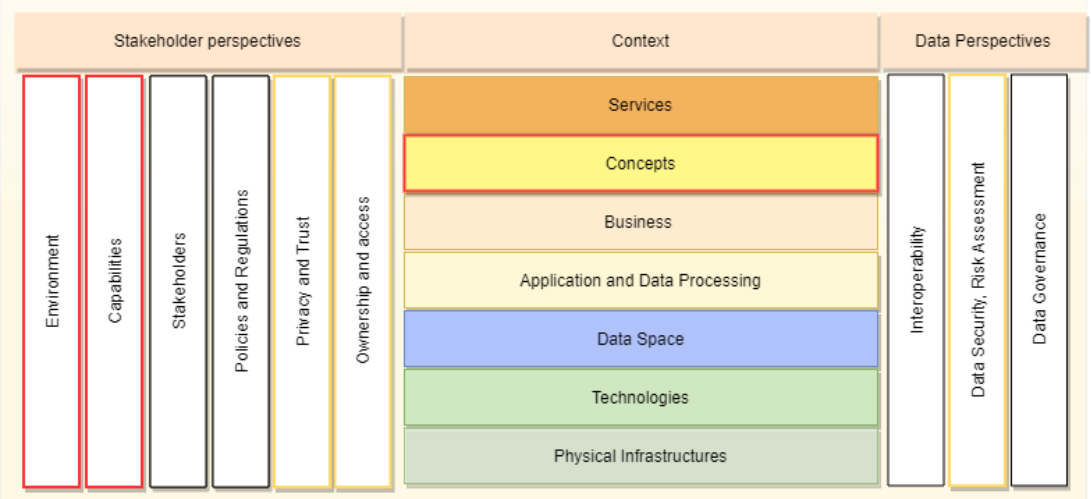

Figure 6.1: Proposed Layered Enterprise Architecture for the provision of home help services. *Added layers are marked with red, while modified layers are marked with orange*

In addition to adapting the layers, entities and relationships to fit the provision of home help services, the main elements that distinguish this EA from the CityXChange architecture are:

- The added concept layer, which ensures semantic interoperability and provides an enhanced connection between the business layer and the service layer to ensure that all relevant entities are defined. This layer will enhance the connection between the business processes, relevant actors and the goals and drivers of the enterprise by including additional support to understand the relevant entities and the relationship between them. This is envisaged to foster a greater coordination in the efforts to achieve the enterprise's goals by establishing a common basis of understanding.
- The capability layer addresses the stakeholders' ability to achieve self governance and includes factors such as the cognitive and physical abilities of the patients and their family. In addition, the technical competency of all involved stakeholders have to be taken into account. This layer is envisioned to provide insight in the users of the systems in order to ensure that the solutions that are developed does not only work on paper.
- In addition to the capabilities of each stakeholder, the environment, such as the physical environment or the family dynamics, has to be taken into account. This layer builds upon the capability layer in addressing the individual differences between the patients

and the resources that they have available. In order to develop sustainable solutions that can work throughout the home care services, these differences must be addressed.

- While privacy and trust, ownership and access and data security and risk assessment were all addressed in the CityXChange architecture, the sensitivity of data regarding patients requires additional security and access control. Thus, these layers have added functionality to ensure that a coordination of resources does not compromise sensitive data.

6.1 Stakeholder perspectives

The architecture proposed in this thesis focuses on providing appropriate care to patients in the comfort of their homes and to avoid premature hospitalization or institutionalization. Therefore, the architecture needs to be developed with a solid foundation in the stakeholder perspectives. To be able to select the right strategies and solutions for home care delivery, the environment and capabilities of both patients and health care personnel must be taken into account. Similarly, the stakeholders involved in provision and consumption of services must be described. In addition, the proposed solutions must be aligned with the policies and regulations of the health care enterprise as a whole in order to be accepted and integrated. Lastly, the health care enterprise stores a large amount of sensitive data regarding patients and their condition, and thus privacy and access control is of paramount importance in order to ensure that the patients feel safe and that all stakeholders trust the system. In addition, it is important to clearly define the ownership of data as well as the actors responsible for verification of generated data.

6.1.1 Environment

When developing solutions, environmental factors are often neglected or misinterpreted and this could lead to solutions that work on paper but fail in practice[76]. Thus, for successful interventions in the provision of home health services, the importance of the home environment in promoting activity, health, and health care must be taken into account. This entails determining the state of the patients' homes, what modifications are needed and, most importantly, if the modifications are possible to implement. Since every patient's home is different, the basis for new technologies could differ immensely and thus it requires a certain modularity in the proposed solutions in order for them to work for all patients. Examples of environmental factors that should be considered are:

- Size of home: Since the sizes of patient homes differ, the solutions should take up as little space as possible.
- Location: Location of the homes could affect factors such as access to internet, travel distances etc.
- State of home: The state of the home can decide how feasible the installation of new solutions is. For instance, if the power grid or data network is outdated it might not support the integration of telehomecare tools.
- Family relations: Family relations could influence how well the patient is able to adapt to the new solutions.

6.1.2 Capabilities

Like with environmental factors, the capabilities of the stakeholders must be taken into account in order to ensure that the uptake of solutions does not fail. Thus, when developing solutions, the patient's mental and physical state should be taken into account and the solutions should follow the principles of universal design (UD) as closely as possible. This will ensure that the solutions developed not only work on paper or in small test studies. For instance, by implementing solutions that do not require the patients to actively partake, such as sensors for monitoring, it lowers the threshold for what the patient must be capable of.

For other stakeholders, the most important factors regarding capability are technical competency and available time. Since most stakeholders involved with provision of home care are stretched on time, the main takeaway from the two above-mentioned factors is that the proposed solutions should be easy to learn and use. If this is not the case, it could lead to slow uptake, or even complete abandonment, of new technologies.

6.1.3 Stakeholders

Stakeholders describe the actors involved in the provision of home help services, including the aggregation and synthetization of health related data. It includes both providers and consumers of the services as well as actors who contribute with knowledge, such as experts or analysts. For this thesis, the stakeholders are limited to the actors directly involved with the provision of home help services and the processes that were chosen to illustrate this. However, this layer should be expanded to include a broader perspective and facilitate coordination and collaboration across several domains. This layer is envisioned to ensure that each stakeholder's perspective is actively contributing to the development of the architecture which in turn will contribute to its continuous evolution. This is facilitated through enhanced communication and integration of feedback procedures.

6.1.4 Policies and Regulations

The health care enterprise as a whole is heavily regulated to ensure the safety of the patients. In order for the overarching goal of shifting the focus away from the traditional institutions for treatment, to be successful, these regulations must be maintained. Thus, it is crucial that all involved actors are aware of the laws, policies and regulations of the health care sector, and that all development is aligned with these guidelines. In addition, the authorities responsible for the regulations should be involved with the development and have in-depth knowledge of what the enterprise is trying to achieve. This way, the stakeholders are able to provide feedback on regulations that act as barriers to further development directly to the policy makers. In turn, this can act as a basis for discussions around the policies and expose the need for revision. Furthermore, by establishing this communication from early stages of the development process, it ensures that resources are not spent on solutions that does not align with the regulations.

6.1.5 Privacy and trust

Digitization of information regarding patients results in easier aggregation of and higher accessibility to sensitive data. This can positively impact the treatment of patients and is of paramount importance to meet the increasing demand of home care services. However, for patients to feel comfortable using the system, they must be able to trust that the information is protected. Thus, the architecture should comply with the general data protection regulation

(GDPR) guidelines in order to ensure that the privacy of stakeholders is maintained at all times. A central principle to comply with the GDPR guidelines is "data protection by design and by default", which means that data protection should be considered at all stages of development and each time data is processed. This includes full transparency of the data processing itself as well as the purpose for the processing. Furthermore, the data collected and processed should be minimized to the information that is necessary for insight in the patient's condition or to determine treatment. This could vary throughout the enterprise and thus access control must be implemented to ensure that actors cannot access information that is not directly relevant to them.

The accuracy of the stored data is also central to the compliance with GDPR regulations, and is important to ensure that the assessment of patients and their condition is correct. This can be aided by full transparency in the collected data, so that the patients can provide feedback if information if it is not accurate, allowing the health professionals to update and correct it. Information that is no longer valid or needed for continued care for the patients should be removed as soon as possible. In addition, all sensitive information should be protected by mechanisms that ensures integrity and confidentiality, such as end-to-end encryption and authentication measures. Furthermore, there should be actors who are responsible for data protection involved in all stages of development. In addition, a detailed documentation of data collected, how it is used, where it is stored and how it is protected should be maintained at all times in order to ensure accountability.

Even if all the principles of GDPR are addressed, the most crucial aspect of privacy in the health care services is the informed consent of the patient. This should serve as a bottle neck for what information is gathered and who has access. The patient should be able to withdraw the consent at any times and if they do, the data should be removed immediately. In addition, no matter how qualified a health care professional is to access information, they should not be able to without the explicit and informed consent of the patient.

6.1.6 Ownership and access

Centralizing the patient record for each patient provides easier access to more valuable and complete information. The information is sensitive in nature and may be protected by confidentiality. Therefore, security measures must be implemented in order to ensure the safety of the data in the digitalization and centralization processes[77]. In order to support this, several factors need to be addressed. From the stakeholder perspective, the terms and conditions around access and ownership must be addressed. Firstly, each involved entity should have complete ownership over their own data but need permission to access data collected by other actors. The access rights of each actor's data should be determined by the actor with ownership of the data, which makes centralizing patient related information even more challenging. So, while all the data should still be accessible through one interface, and thus for the user appear to be a single record, it could be spread across several interconnected sets of data. This is the basis for the British Medical Association (BMA) security policy, which defines the medical record "[..] not as the total of all clinical facts relating to a patient, but as the maximum set of facts relating to a patient and to which the same staff had access"[78].
BMA's function is to prevent the spread of identifiable records through the enterprise and enforce patient consent through principles like access control, consent and notification and information flow control.

The data perspective of these functions will be discussed in subsubsection 6.2.2

6.2 Data perspectives

In order to ensure that the coordination of systems, actors and information runs smoothly, the solutions must focus on interoperability at all layers of development. Furthermore, security must be addressed from a data perspective as well in order to ensure that privacy is maintained. This security is further enhanced by implementing enterprise-wide standards for data governance. If all actors involved manages the data in the same manner, this fosters consistency which in turn leads to higher quality in the data.

6.2.1 Interoperability

The health care enterprise is complex and changing and there are often several actors that must combine their efforts in order to meet the user's needs. In order to foster cooperation, all stakeholders should have a common vision and align their priorities to reach these through an agreed upon set of objectives. As mentioned earlier, the most prominent challenges with the digitization of home health services are information exchange and collaboration technology. The duplication of efforts, lack of communication within and between organizations and patients, as well as the diversity of actors involved with the enterprise exposes the need for interoperability in and between all layers of the architecture. It is important to note that interoperability is not solely an ICT matter and has layers of implications ranging from legal to business to technical. The actors, processes and documentation involved with the service provision should also be included when addressing interoperability. Interoperability issues in the health care sector were first explored in the specialization thesis leading up to this master thesis[79].

To succeed at implementing interoperability it is crucial that interoperability is recognized as a multi-dimensional issue that requires a holistic approach. The four main layers of interoperability are technical, legal, organizational and semantic (which also includes syntax)[80]. Technical interoperability refers to all technical equipment, including applications and interfaces, as well as data exchange and communication protocols. Here, it is important to establish protocols to facilitate sharing of data and ensure easy access through available APIs. Next, different components within the enterprise should be designed in accordance to the same policies, laws and regulations to ensure that they are consistent and compatible.

When managing interoperability efforts, one should facilitate processes that can identify relevant standards and specifications and evaluate them and their implementation as well as their interoperability. For this evaluation a transparent and non-biased assessment should be used. It is important that they are standardized throughout the enterprise so that the recommendations are consistent throughout. Once evaluated, the standards and specifications can be used, alongside an enterprise-wide set of guidelines, to implement frameworks and systems. If there are changes needed, these must be managed with standardized and suitable procedures. Lastly, it is cruicial to document the standards and specifications to ensure that they are used throughout the entire enterprise. In order to do this the legal barriers must be explored, by identifying systems or components with contradictory requirements for the same processes, too restrictive rules or poor security and data protection. Thirdly, organizational interoperability addresses how an enterprise's goals, processes and responsibilities align. This can be achieved by establishing standardized business processes and document them in an accessible model so that all involved actors get a good understanding of their role in achieving the goals. Lastly, semantic interoperability means that what is sent,which includes the format (syntactic interoperability) and data as well as the information, is understood and preserved. This re-

quires coordination of the information management strategy at a high level in the hierarchy. By defining concepts and their attributes high in the hierarchy, the amount of fragmentation and duplication throughout the enterprise is reduced. It is crucial to develop maturity in the semantic interoperability layer in order to reach the full potential of streamlined processes.

6.2.2 Data security, Risk assessment

As discusses in subsubsection 6.1.6, health care professionals should not be able to access every patient's record or all information of specific patients. Thus, rules to ensure that actors can only access information relevant to the treatment of specific patients under their care is needed. This can be done through access control, which decides what resources and information stakeholders, processes and systems can access[78]. This includes what files they can read, who they can interact with and what processes they can be involved with. One approach to this is to implement a multilevel security model which relies on classification and clearances as well as information flow control. Classification is traditionally used in the military where documents are rated from unclassified to top secret, as seen in Figure 6.2.

Figure 6.2: Multilevel security in which sensitive information is protected by classifications and clearances

For the health sector, the unclassified information would be general information in which it would be impossible to identify the patients identity, and top secret would be all information, like name and birth date, available. For clearance, each involved actors would have to be assessed for how involved with the patient they are and what information is relevant to the job they are doing. In order to access information, the clearance must be at least the same as the information's classification. This requires information flow control, which states that actors with high clearances can access data with low classification, while actors with low clearances cannot tell whether or not the classified information is even there. For instance, with access to unclassified information about a patient (generalized information), an actor should not be able to determine if the information is based on a real patient or a hypothetical scenario.

In addition to implementing multilevel security measures, which prevents data from moving

down the hierarchy, it is also important to ensure that data does not move between departments. This entails that an actor can only accesses information from other branches of the enterprise if it happens under strict control, with full traceability and accessibility. Thus, there is only a small portion of unclassified data that is available to all actors, while most of the data is protected by access control, as seen in Figure 6.3. The confidentiality of lateral information flow controls should be based on the patient's rights and focus on ensuring their safety but be enforced by limiting medical record access to particular departments in the home care service provision.

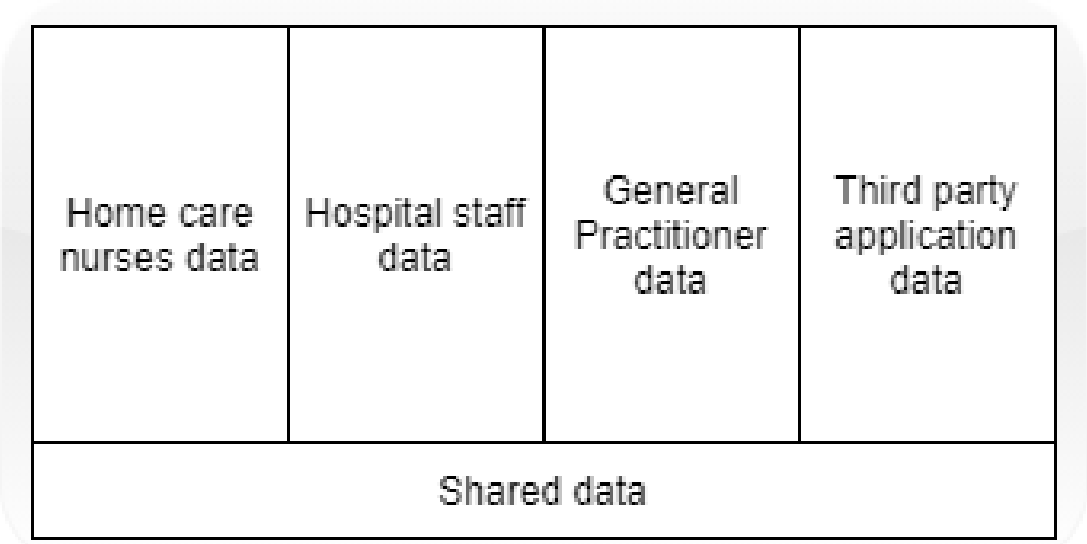

Figure 6.3: Multilateral security in which only unclassified data is available to all actors. Information can still be shared between branches, but under strict control

It is also important to note that sensitive information could be obtained through for instance statistical data that could be used to identify the patients if the 'attacker' uses enough queries. To prevent this kind of information leakage, inference control techniques, which is supported by privacy enhancing technologies (PETs) such as de-identification or obfuscation, should be implemented.

Furthermore, the use of digital tools for documentation of and access to patient information requires authentication, authorization and encryption tools in order to ensure that security and privacy are maintained. Since the records are online, there is also the risk of data tampering, so there must be procedures and tools in place to ensure integrity, for instance adherence to the principles of the BMA security policy. In addition, the solutions that are developed must be robust in the case of malicious users. For instance, if a solution is dependent on continuous synchronization through the internet, a denial-of-service attack could potentially be life-threatening. Thus, there needs to be procedures for what to do in the case of network downtime, as well as asynchronous information exchange. Authentication should be the first step of any information sharing process as its primary objective is to ensure the identity of the actors involved. After this, the authorization level decides what data they are allowed to access.

In order to implement several security levels on the same devices, virtualization could run

underneath the operating system to create several virtual machines. The information flow between these virtual machines could be controlled or prevented based on the authorization of the user. While this provides the system with high-assurance separation of information located at the different levels of classification, it will feel like one coherent system to the users. However, an issue with virtualization could be the fact that people often need information from lower levels of classification (they cannot access higher even if they needed it), and thus the security of the system may be compromised. The security breach is more about the human error than the technological solution, but it should still be addressed For instance, if a third party service provider's data is important to assess a patient's condition, an authorized health professional might access that data through their device. However, if the health care professional then was to continue working at the unclassified level, the risk of compromising sensitive data is very high. To mitigate this, a *pump*, which is a one-way data transfer device, could be implemented to transfer data from low to high while preventing data flow in the other direction. An overview of the security measures discussed in this section can be seen in Figure 6.4.

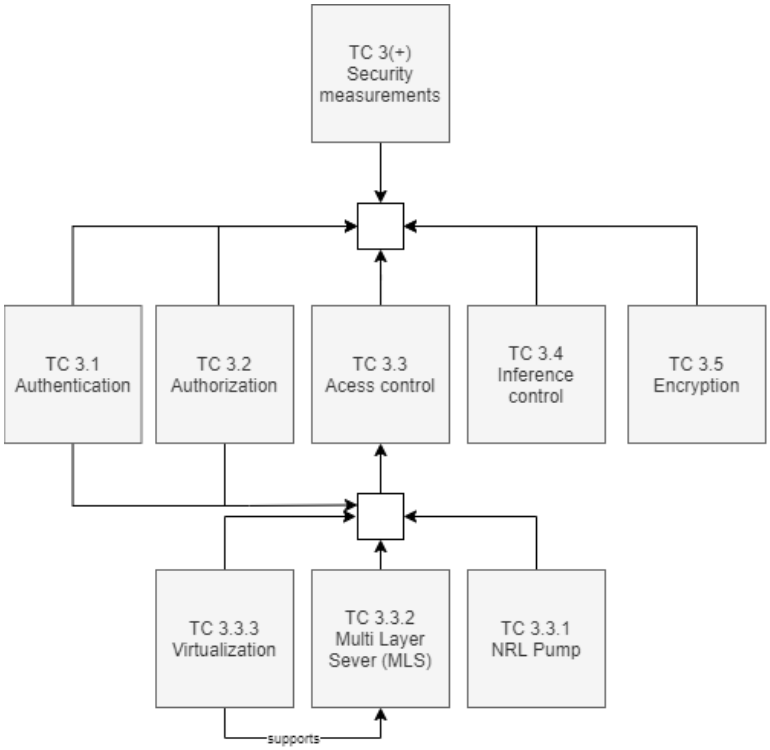

Figure 6.4: An overview of security measures

In addition, there must be implemented procedures for information sharing and access control in acute situations. For instance the scenario where emergency personnel needs access to sensitive information that they cannot normally access, and there is no time for the appropriate vetting in order to establish access control. In this situation, the most crucial aspect is accountability and traceability to ensure that the "crisis access" cannot be misused. An example of such a solutions is sealing the sensitive information, but allowing the seal to be broken in the case of an emergency. By accessing the information, the seal will be visibly broken, and relevant authorities or actors responsible for security should be notified.

By implementing the above mentioned security measures, the data security principles of confi-

dence, integrity and availability (CIA-triad), which are widely used as a benchmark for assessing the security of information systems, are addressed.

Lastly, since the home care service provision is extremely complex, it is challenging to mitigate all potential threats to the system. By implementing risk assessment, potential threats are explored, before the likelihood and severity of the threats are assessed. Based on this, a detailed plan with prioritization of security measures to mitigate the threats is devised. It is important to note that this plan is not static and should be revised continuously as new risks are discovered or old ones are patched.

6.2.3 Data governance

In order to ensure the quality of the data, it is important to maintain and handle it consistently throughout the enterprise. This is crucial in order to enable coordination and interoperability and must follow a set of principles in order to be achieved. These principles were first explored in the specialization report leading up to this master thesis.

The first principle is subsidiarity and entails that decisions should only be made high in the hierarchy if this is *more* efficient than making the same decision lower in the hierarchy. That is, the decision makers should be as close to the aspect of the enterprise that is impacted by the decision as possible. For the health care industry this may entail that the use of resources such as medicine usage for individual patients is decided locally (low in the hierarchy), but framework for the systems used in the hospitals is decided nation wide (high in the hierarchy).

The next principle is openness and states that all data should be available for use and reuse by others. In the case of health care enterprises there are a lot of personal data and confidentiality, so this might prove a challenge. Nevertheless, stakeholders within the enterprise should easily be able to access data they are authorized and entitled to in accordance with the enterprise's security principles.

The third principle is transparency and entails that any stakeholder in the enterprise should be able to see the processes that lead to decisions and understand their results. This means that any system within the enterprise should be intuitive to use and each actor should understand how it is connected to other systems within the enterprise as well as why that particular system is in use. For instance, if a patient is getting treatment from several institutions, the discrepancy between what information the patients expect the individual institutions to have access to and what they actually have access to should be minimized.

A problem encountered within the health care enterprise today is, as mentioned, that the systems provided, both internally and by third party service providers, are different, disparate and inconsistent with both functionality and framework. Thus, a good model promotes reusability and replication of solutions, which can be done through for instance the introduction of open data models.

The next principle, accessibility, entails that all stakeholders, including people with disabilities, elderly etc., should be able to use the services provided by the system in the same way as other users. This could include multi-channel delivery, which includes information sharing through not only digital channels, but face-to-face and paper based as well. However, one should strive to have a service digital-first as long as it is possible. This means that for any service provided, the digital channel is prioritized, but that the digital and physical channels co-exist. Lastly, accessibility would also entail having a single point of contact to reduce perceived complexity

by concealing the internal workings of the system from the user.

Security and Privacy are two central principles in the development of a system within the health care industry. Any patient or health care professional should feel confident that their interaction with the system is secure and that their privacy is taken care of. An enterprise-wide framework for security and privacy, as well as good routines throughout is of paramount importance to ensure this. Thus, appropriate security measures should be implemented.

The next principle entails that administrations should simplify the data handling as much as possible and eliminate that which does not provide value. A good example of this is several disparate systems storing the same data. This could be regulated with access control and virtualization, as discussed in subsubsection 6.1.6.

Next, the enterprise should have a long-term plan for preserving the information relevant to the services it provides. This may include converting existing, physical information to digital media or updating the procedures for documentation. In Norway, for instance, such an update is already underway with regards to the patient journal[13]

Lastly, the enterprise's solutions should be under constant assessment with regards to user feedback, risk vs rewards, privacy as well as costs and benefits. This will ensure a positive evolution for the enterprise and aid in the effectiveness and efficiency of its data governance.

6.3 Layered Architecture

The EAF takes a layered approach which means that the lower layers support the higher layers. What this also means is that everything included in a lower level should somehow be connected to a higher level. This enables the users of the architecture to examine high level ideas and trace their entities and relationships through the framework in order to obtain an understanding of the actors, systems and data involved with achieving the goals or improving the processes.

Context Layer

The top level of the EAF is the context layer which describes the high level goals of the enterprise, that functions as drivers for the development of solutions and digitalization. They are based on the needs of the stakeholders as well as national and local guidelines and visions for further development. Every choice the enterprise makes should support the overarching goals presented in the context layer to ensure that the development of the enterprise revolves around the stakeholders' requirements.

Service layer

The next layer is the service layer and describes the services that are necessary to implement in order to achieve the goals in the context layer. The content of a service is directly connected to one or more of the goals in the context layer and contains objectives specific to their achievement. Thus, it provides an overview of the factors and aspects that are required to achieve the overarching goal of the context layer. For this thesis, three main services were chosen, each containing important sub-goals obtained from the analysis in section 5. This is illustrated in Figure 6.5.

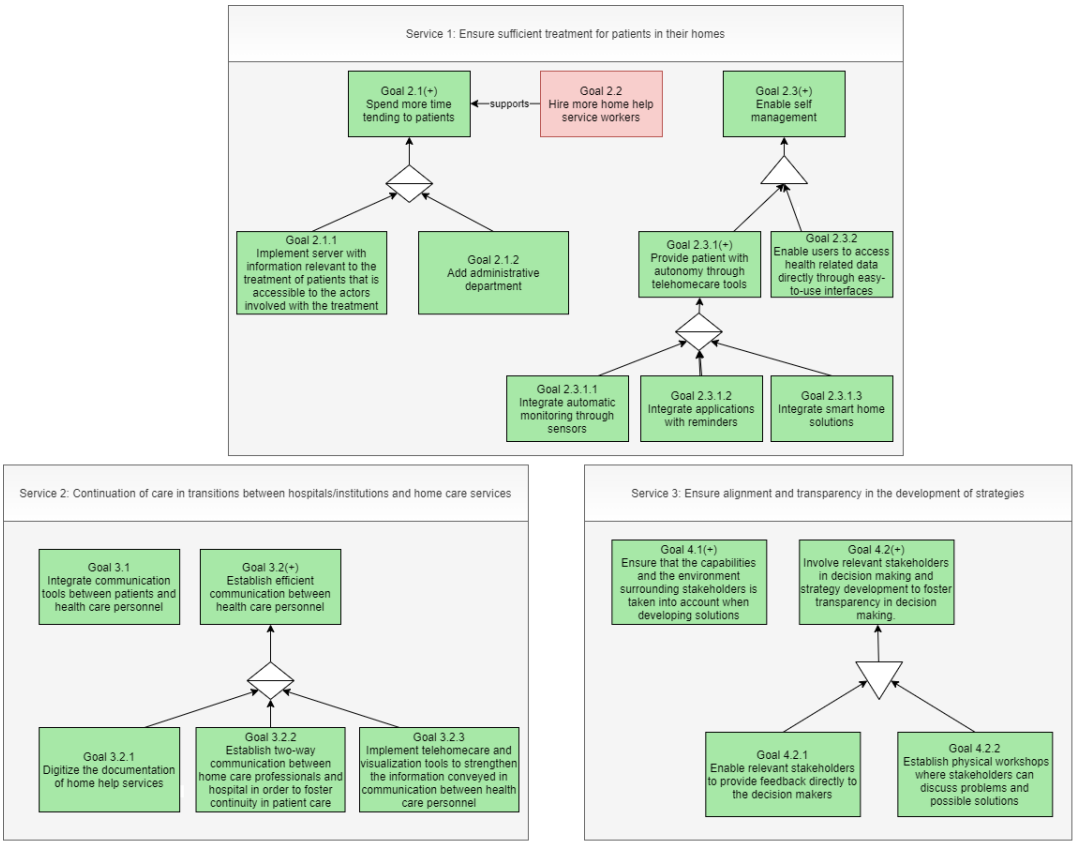

Figure 6.5: The services contain sub-goals that must be met in order to achieve the overarching goal in the context layer.

Concept layer

After this, the concept layer is added to enhance the coordination and cooperation of the technical and business actors by ensuring a mutual understanding of all relevant entities and definitions relevant to the implementation of services. This is especially important since a major issue in the development of EA so far has been a lacking commitment and eventual abandonment of projects[17]. To mitigate this, it is crucial to ensure that the ideas and principles that are implemented are communicated well throughout the enterprise. Currently, there are major issues with communication between the developers of the technological solutions and the management of the enterprise. If the benefits and necessities are not understood by the decision makers, for instance because of differences in terminology, the value of the EA framework may never come to fruition[17]. At the same time, if the developers do not fully understand the goals of the enterprise or the legislations they operate under, their solutions may be incompatible and thus not usable[70].
Based on this, the relevance of the concept layer to the success of the EA efforts is confirmed.

Business layer

The business layer describes the different processes and actors that are involved in providing the service to achieve the enterprise's goals as well as how they are related. Another function of the business layer that the entities in the concept layer are defined by the actors and

through processes. This is an important task to support interoperability since it is important that the definitions are standardized and used throughout the enterprise. The CityXChange architecture also included virtual enterprises, which are defined as when two or more actors cooperate temporarily to better support the service provision, supported by data networks[81]. An argument could be made that this is what the different branches in the enterprise do, but it will be more relevant to include when the framework is expanded with more external actors.

Application and data processing layer

The application and data processing layer describes the different platforms and applications that is required by the business processes. This could include tools for analysis of patient related data or a platform for logging observations on the patient's condition. The former could be extremely complex based on the amount of data from the data space layer and thus require specific analysis tools. In addition visualization tools to support the health personnel's internal communication or communication with the patients. It could also entail platforms for providing, accessing and navigating information spaces, for instance the feedback data obtained from home care personnel.

Data space layer

The next layer is the data space and contains all the data that is relevant to the business processes and services. This includes both public and private data sources. In addition, it contain relevant information about the enterprise and its governing as well as information regarding the patients and their condition. The latter could be data from automatic sensors, observations by home care personnel or test results from consultations with specialists, hospitals or general practitioners.

Technology layer

Next, the technology layer describes the technologies that support the data space layer. It includes the servers for patient data and sensory information from the telehomecare tools as well as third party applications and their integration. In addition, the security measurements that ensures that the data is not compromised are described in this layer. This is also where a payment system for consultations in the home, as proposed in the focus discussion in section 7, should be implemented.

Physical infrastructure layer

The last layer is the physical infrastructure layer which consist of all the physical infrastructure and components that are required in order to achieve the desired state of home help service provision. It describes the physical devices that the actors need to access the technology and data in the other layers. This includes components necessary for effective and efficient business processes. Lastly, it describes how, and by what, the data is collected, through for instance telehomecare tools, such as sensors, or tablet devices for logging. This transparency about how data is collected is crucial in order to be offer reassurance to the stakeholders and be in accordance with the GDPR rules.

The next section illustrates how these layers interact within the home help service enterprise based on the analysis in the previous chapters.

6.4 Application of Enterprise Architecture Framework

Through analysis of the current and desired situations with help of TOGAF ADM and 4EM modelling, various central components and entities, as well as their relations, can be proposed used within the layered architecture in order to facilitate better provision of home help services. The proposal can be seen in Figure 6.6 and is based on the literature review and discussions of the current and desired situation. This is not to be treated as a static solution, but as a dynamic architecture that can be iterated on and changed based on feedback and usage.

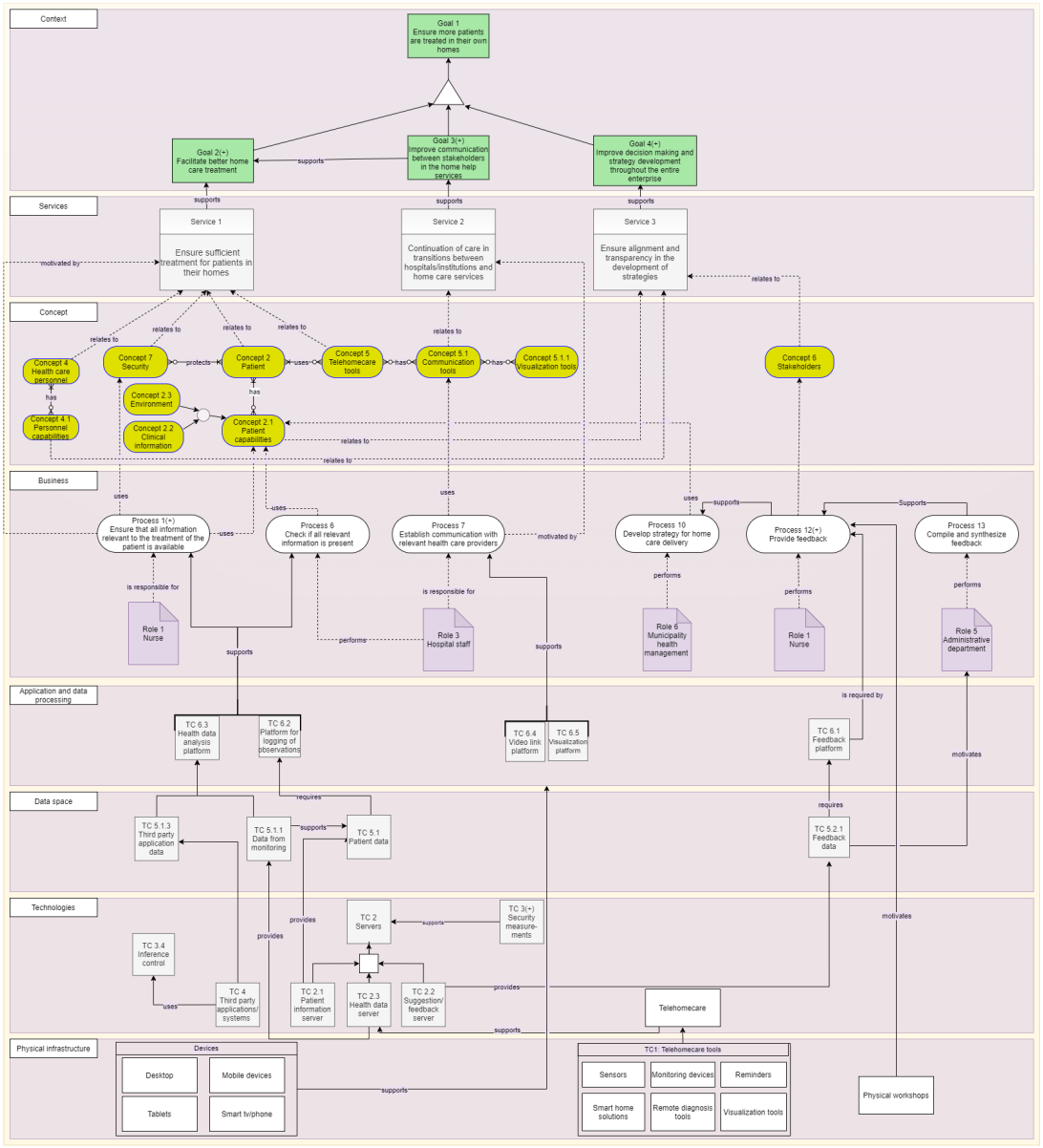

Figure 6.6: A proposal to how the EAF could be applied to the home help services.

That way, it creates a solid foundation for further discussions and a mutual ground for all involved actors so that they can clearly see what the enterprise's goals are reliant on, all the way down to the details of technology and physical devices. This is envisaged to mitigate the issues of poor coordination between the technical and business departments which has lead to

project abandonment in earlier stages. By ensuring that everyone has a shared vocabulary and understanding of how the entities in the enterprise are interconnected, the solutions are more aligned through all layers of the enterprise.

The model illustrates how enterprise architecture can be used to enhance the provision of care by aligning all layers of the enterprise to work towards the same goal. While this can be shown with a limited amount of entities, like actors and processes, it is important to note that the enterprise architecture can be expanded to include more entities. This could for instance be other relevant health personnel such as physical therapists, psychiatrists etc., institutions such as health stations or goals, for instance related to profit and cost efficiency. For this thesis, this was deemed out of scope as the actors and processes chosen were considered adequate to demonstrate the application of enterprise modeling and enterprise architecture.

7 Evaluation

The aim of this thesis was to identify requirements for the transition from the current to a desired state in the home help service provision, and illustrate how an EAF could aid in achieving it. The product of this analysis was a proposed EAF with recommendations for central entities and principles that are needed.Since the creation of a framework is an iterative process, it is important to receive feedback and evaluations that can be used to refine the model. For this thesis, the feedback was collected with a qualitative approach based on a set of evaluation criteria. The feedback was collected through a focus discussion and an online questionnaire.

7.1 Evaluation criteria

The evaluation criteria were chosen to ensure that the quality of the produced model and framework were high and to assess how well it addressed the provision of home help services, which was based on established quality criteria for EAF and EAM[82][64][83]. In addition, it was useful to to evaluate the perceived usefulness, usability and behavioral intention which can be achieved through a technology acceptance model[84]. The chosen evaluation criteria are summarized in Table 7.1.

7.2 Focus discussion

For evaluating research, focus discussions have been proven effective to obtain diverse feedback that can expose challenges and provide further insight on what is required to fill in the gaps between current and desired situation[85]. By including several participants, they are able to expand on each other's arguments and thus it provides a more in-depth feedback than any one individual could provide[86]. To ensure that the information obtained was relevant to the evaluation criteria, a set of questions were developed to guide the discussion. The goal of these questions were not to function as an interview, but to stimulate discussion and naturally guide the conversation towards the relevant information. The participants were encouraged to interpret and expand on the questions, and thus the questions were subject to reformulation which could expose new challenges and general aspects of the framework that should be addressed. The focus discussion was initiated with a presentation of the domain of home help services, the modeling of the current and desired situation and the proposed architecture before the discussion was initiated. In addition to the questions in Table 7.1, the participants were encouraged to stop the presentation if there was anything unclear or if they had any immediate feedback and there was also an opening question ("What are your immediate thoughts"). This was done to enable the participants to frame the conversation before the guiding questions steered it towards the chosen criteria. That way, any criteria that could be important but that were not taken into consideration, could be included.

7.2.1 Results

The evaluation from the focus discussion was mainly positive and the general feedback was that the domain was accurately described and that the problems identified were relevant. They also assessed the layers and entities to be a good way of aligning the business and convey essential information. While the guiding questions lead the conversation towards all of the quality criteria, several of the quality criteria were assessed as fulfilled and were thus not the focus of the participants. An example of this could be getting short, affirmative answers, for instance

Table 7.1: Quality criteria for evaluation of proposed framework

Criteria	**Relevant question**	**Medium**
Concreteness	Are the proposed elements relevant and correct?	Focus discussion
Completeness	Are the relevant entities, actors and relationships addressed?	Focus discussion
Accuracy	Is the domain accurately represented?	Focus discussion
Modularity	Can the developed solutions be adapted to changes in the domain?	Focus discussion
Simplicity	Are the entities and relationships presented concretely?	Focus discussion, questionnaire
Understanability	Is it easy to understand for the various stakeholders	Focus discussion, questionnaire
Security	Does it address the security of the stakeholders	Focus discussion, questionnaire
Alignment	Does it enhance alignment in the enterprise?	Focus discussion, questionnaire
Participation	Is it clear for whom the various parts of the model are relevant?	Focus discussion
Unambiguity	Does the model invite different interpretation from stakeholders?	Focus discussion
Usability	How well can it be used for its intended purpose?	Questionnaire
Intention of use	How appealing is it to use?	Questionnaire

"Yes I agree", without any elaboration from all participants. If one or more participants did not reply, for instance because of a digression from another participant, the question was revisited. However, if all participants had answered affirmatively, the criteria was deemed as met and the discussion continued. An overview of the most central issues discussed will be described in this section.

The first issue that the participants raised was the challenge of conveying that the stakeholder, and especially patient, was in the center of development. Thus, they requested more focus on where the patient was in the proposed architecture. The suggestion was to include scenarios and challenges directly affecting the stakeholders to illustrate how the layers and entities within the EAF are developed with focus on the stakeholders.

Next, the gradual shift from traditional health care into the homes requires reevaluation and iterations, which needs mechanisms and guidelines. It was not clear from the EAF what would change, how these changes would be addressed and how the solutions would have to adapt to meet the changes.

Another issue that was raised was the lack of quality assurance and accountability of information exchange over the phone when diagnosing a patient. These conversations could often be highly informal and yet define how the patient was treated. In order to address this, the information exchange cannot be anecdotal, but should be logged and traceable with established rules for information verification, so that the actors responsible for a decision must stand accountable for it.

For the environmental layer of the EAF, the participants all stressed that the involvement of informal caregivers, such as family, was very complex. Firstly, the informal caregivers do not really fit into the current home help service systems, and are legally in a limbo. For instance, one participant had a parent who was diagnosed with dementia, but the family was not informed. Due to loss of hearing, there was a misunderstanding when the parent was told of the diagnosis, so they were unaware of their condition. Thus, they deteriorated without anyone in close family having knowledge of the diagnosis because they were not legally allowed to access the patient information. On the other end of the spectrum, one participant had encountered a patient of which the spouse of the patient was abusive and thus posed a problem to the home care service provision. The patient could not speak freely and in this scenario, it could be detrimental to give the caregiver more access or power over the patient and their condition. Another participant elaborated on this and stated that there were cases were the informal caregivers had been given access to the finances of patients and used it for personal financial gain. This discussion culminated in the question of whether or not the solutions and society would want a dependency on informal caregivers at all.

The example of the parent with dementia also sparked a conversation on how to handle patients with dementia in general. This is a challenge in the current home care services with examples of patients that do not remember having visits or if they have taken medications. This is not just unpleasant for the patients, but could lead to increased use of resources for the home care professionals that have to deal with it. The solutions developed must address this and define what this particular group of patients require.

In addition, it should be decided whether or not patients with dementia or other limiting illnesses should have full access to their own health data. One participant had worked on a case with mentally ill patients and whether or not they should have access to their health data. While the health care providers strongly disagreed to this policy, both the patients and the law (makers) were in favor of giving them full insight.

Another issue that was discussed was the need for timeliness of information in cases where the patients moved around a lot, for instance in and out of institutions, visits to specialists and home care delivery. In these cases, the information submitted, and especially the order in which it was submitted, was hard to track. This ultimately lead to issues with identifying which information was relevant, up to date and correct. Delays in submitting information could worsen this issue further. One of the participants told of situations where patients could get several prescriptions to the same medicine from different health care professionals because the first subscription had not been synchronized with the system.

Lastly, one participant brought up the inclusion of a payment system to facilitate for in-home

consultation.

7.2.2 Limitations

Both the the models and the framework, as well as the domain of home help services are complex with a lot of nuances and factors, and it was impossible to convey all details of this thesis in the short presentation leading up to the discussion. This resulted in elements and issues that were already addressed being discussed. Since the discussion of these topics still had the potential to reveal issues or challenges, it was not dissuaded. An example of this could be when the participants discussed the protection of security and access control through authentication and authorization, which are addressed in subsubsection 6.2.2. This could prove to be a limitation, since it resulted in less time for discussion on other topics and could have been avoided if the participants were provided with a fuller overview of the work done in the thesis (or the entire thesis) beforehand. However, this would drastically raise the bar for participating and since recruiting participants had already proven to be challenging, it could have resulted in participants withdrawing or failing to attend.

7.3 Questionnaire

In addition to the focus discussion, a technology acceptance model (TAM) was used to get more specific insight in the participant's attitude towards the system. TAM is a widely used model because of its simplicity and understandability as well as its reliable and valid results[87]. It is especially useful to conceptualize the usefulness and ease of use to predict the intentions of adopting new systems[84]. This is particularly useful as an addition to the focus discussion where the feedback is nuanced and thus challenging to concretize to measurable factors.

The model suggests that there are three main factors that decides a user's attitude towards a system, and that this attitude is highly indicative of whether they decide to use or reject the system[88]. These three factors are perceived ease of use, which indicates how much effort it takes to use the system, perceived usefulness, which addresses whether or not the system enhances the user's performance, and and behavioral intention, which explores if the user could see themselves applying the system in a job setting. The result from the TAM evaluation, and especially the behavioral intention, is assumed to be closely linked to actual behavior and the model is considered reliable and robust for predicting user behavior[87].

In addition to the three established categories for technology acceptance, two more categories were added, namely introductory statements and stakeholder concerns. Firstly, the introductory statements were chosen to get an idea of how well the participants knew the home help services and if they were used to models and architectures. This was done to ensure that the answers were not influenced by lack of knowledge or understanding. Next, two statements regarding central stakeholder concerns were added. As discussed in previous sections, privacy and trust are paramount to whether or not the patients would adopt the system, and as such it is considered central to technology acceptance. Furthermore, the business side of the enterprise focuses on gaining maximum value for resources spent, and thus the cost of implementing the EAF is considered central to technology acceptance. Thus, this resulted in a questionnaire that consisted of ten statements divided into into five categories. For each statement, the participants rated their level of agreement according to a five-point Likert scale ranging from strongly disagree and disagree, through neutral, to agree and strongly agree[89]. The statements and their category can be seen in Table 7.2.

Table 7.2: Statements used in the TAM questionnaire

Satements	**Category**
I have good knowledge of enterprise architecture frameworks	Introductory
I have good knowledge of the home help services	Introductory
I think it is useful to the provision of home health services to implement this EAF	Usefulness
I think implementing this EAF will make it easier to align business goals with technological solutions within the home health services	Usefulness
I think using the EAF would improve efficiency in the provision of home care services	Usefulness
I think finding relevant information in this EAF is easy.	Ease of use
I think becoming efficient with this EAF is easy	Ease of use
Given that I had access to the EAF, i predict I would use it.	Behavioral intention
I think using this EAF would put my privacy at risk.	Stakeholder concern (patients)
I think implementing this EAF would be too expensive	Stakeholder concern (business)

7.3.1 Results

The results from the introductory statements can be seen in Figure 7.1 and establishes that none of the participants are unfamiliar with the domain and so the answers provided should be accurate and not influenced by confusion or lack of knowledge. From these results, the participants were evaluated to have the the necessary knowledge of the domain of home help services and its context, as well as to have adequate knowledge of EAFs to interpret and understand the models used.

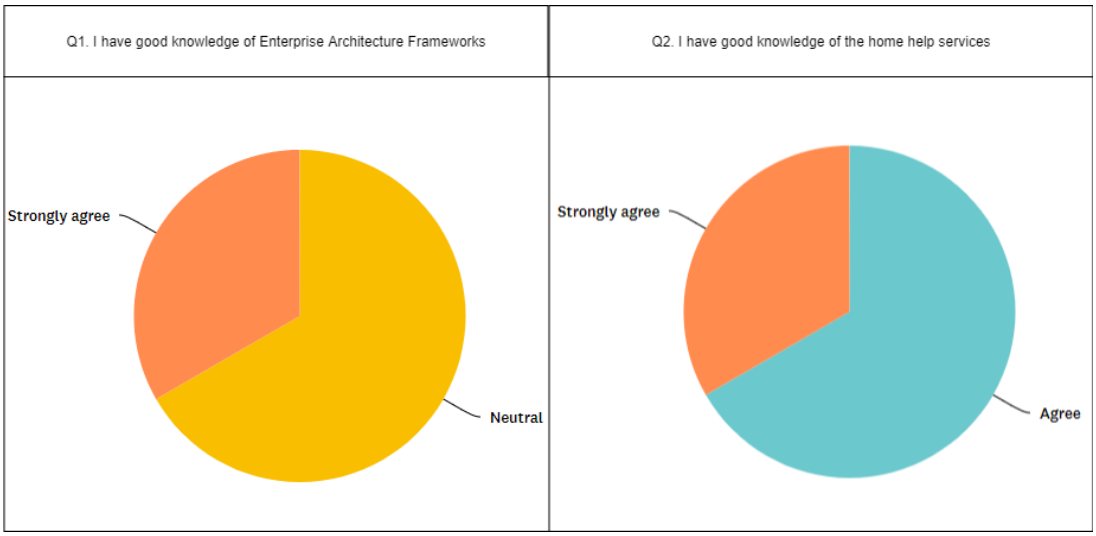

Figure 7.1: The result from introductory statements

As seen in Figure 7.2, all participants agree, or strongly agree, to the usefulness of the EAF to the provision of home health services and the alignment in the enterprise. However, the results from the statement of increased efficiency are inconclusive. This indicates that there may be factors relating to the efficiency of home care services that were missing or not well-represented in the framework.

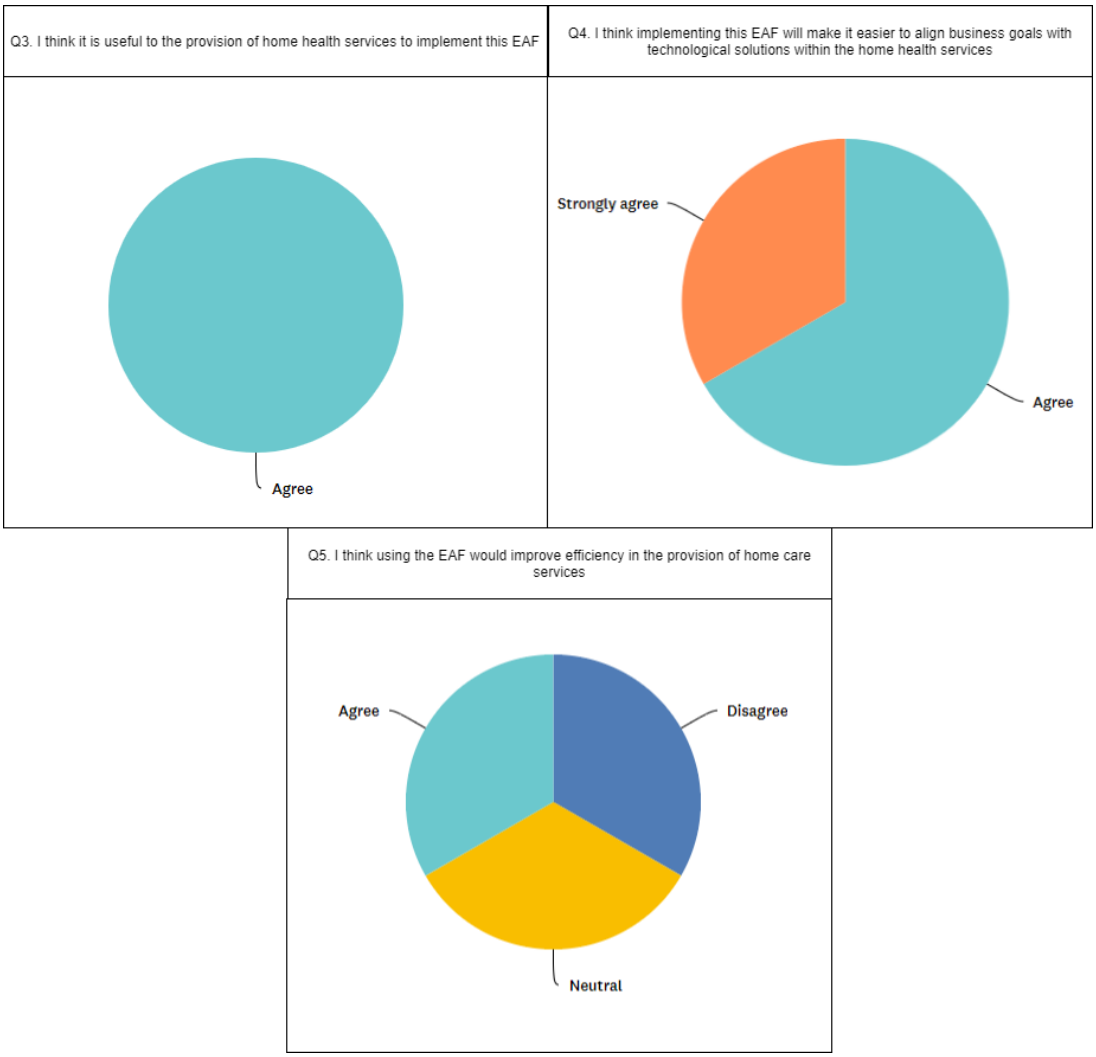

Figure 7.2: The result of statements regarding perceived usefulness

The results in Figure 7.3 indicates that while finding relevant information in the framework was perceived as easy, none of the participants had any thoughts on how challenging the process of becoming proficient with the EAF would be. Thus, the ease of use must rely solely on the positive feedback from the first question, which was mainly positive.

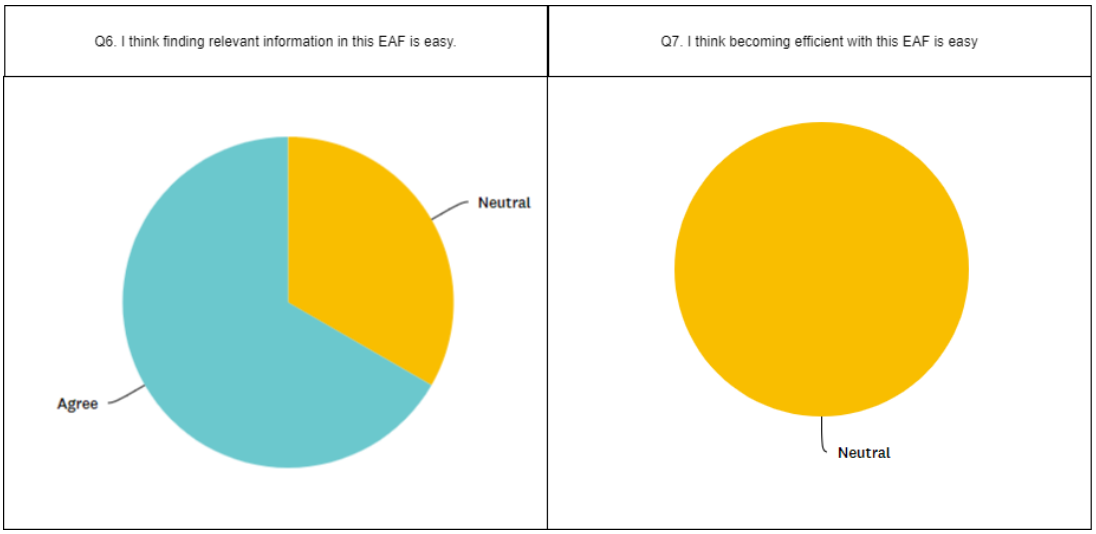

Figure 7.3: The result of statements regarding perceived ease of use

As expected, the result in Figure 7.4 is closely correlated with the results obtained in perceived ease of use, with the same exact distribution of "agree" and "neutral".

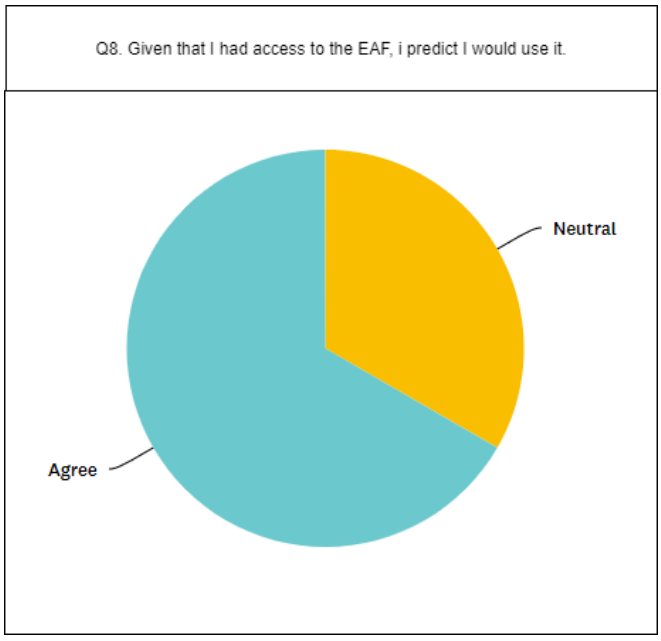

Figure 7.4: The result of the statement regarding behavioral intention

Lastly, as seen in Figure 7.5, the participants did not assess the EAF to put the stakeholder's privacy at risk. They did not indicate whether or not they thought the EAF would be too expensive, but this could also be a result of the phrasing since "too expensive" is inaccurate and raises questions like "too expensive compared to what?". In order to avoid this, a more concrete phrasing should be applied for future iterations.

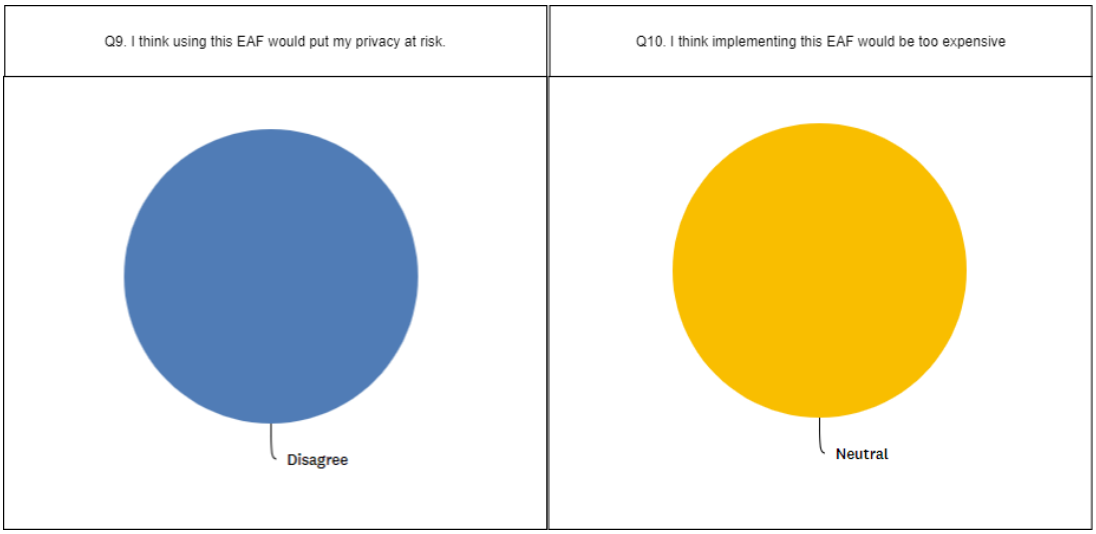

Figure 7.5: The result of statements regarding stakeholder concern

7.3.2 Limitations

The phrasing and formulation of questions should be continually revised in order to ensure that inconclusive answers are not a product of confusing or poorly phrased questions. For instance, since there are two inconclusive questions that used the word "efficient", it could indicate that the meaning or context of the word was confusing. For instance, Q7: *"I think becoming efficient with this EAF is easy"* could be read as "I think it would be easy for me to use this EAF efficiently" or "I think becoming efficient with the use of this EAF is easy". Thus, it does not necessarily make it clear whether the question is regarding ease of use or its usefulness to the enterprise as a whole. In addition, efficiency is a rather broad term and a rephrasing of these questions could be beneficial for future evaluations.

7.4 Action plan

Based on the feedback, the following action plan was created for implementation. Some of the action points are too complex to address in this thesis because of limitations of time and scope. However, they establish a basis for future work. In addition, some of the action points are implemented or elaborated upon throughout the thesis and it is therefore challenging to point to specific places where these changes were made, although this is done where possible.

- Implemented: Include specific examples and scenarios of how the stakeholders fit into the architecture
- Implemented: Specify the changes the shift from traditional health care to home care introduces.
- Partly implemented: Further develop quality assurance and accountability in information exchange, see Figure 4.4 and Figure 5.1.
- Implemented: Discuss the involvement of the informal caregiver as a stakeholder, see subsection 2.4
- Partly implemented: Discuss how to deal with patients with illnesses like dementia or mental health issues.

- Partly implemented: Expand on the issues of timeliness of information and how to deal with synchronization
- Partly implemented: Implement a payment system, see Figure 5.11
- Future work: Indicate the cost vs benefits of implementing the architecture

7.5 Limitations

The evaluation of the framework should include various stakeholders with different values into account, while this evaluation process mainly involved actors with high technical competency and less focus on the business side of the enterprise. This could for instance be a reason for why the participants were neutral to the business stakeholder question regarding cost of implementation. This homogeneity was a product of low availability of willing participants, and for future evaluations, it would be beneficial to involve a wider variety of stakeholders. However, the evaluation still provided valuable feedback for further iterations and refinements.

Initially, there were planned more and longer focus discussions with various stakeholders, but since it was challenging to obtain participants, perhaps due to the ongoing pandemic, the amount and duration was reduced to ensure that an evaluation could take place.

8 Conclusion

The introduction of the thesis raised five research questions:

- RQ1: What is the current situation of the home help service provision?
- RQ2: What is the desired situation of the home help service provision?
- RQ3: How can telehomecare tools enhance the provision of home help services?
- RQ4: How can Enterprise Architecture and Enterprise Modeling support the integration of telehomecare tools in the home help services?
- RQ5: What modifications must be made to the CityXChange architecture for it to be used efficiently in the home help service provision?

In order to address RQ1, a solid understanding of the current state of the home help service enterprise was established through a semi-structured literature review. Here, the problems and opportunities were explored by examining the current challenges in the organization of care as well as the technical architecture and business processes. This overview was structured through enterprise modeling to shed light on issues that hindered the efficient provision of home help services. This revealed several bottlenecks for care provision, the main problem being that the traditional institution-based health care provision does not have the capacity to face a rapidly aging population. To address this, issues regarding lack of interoperability, disparate information silos and poor organizational alignment were examined. The solutions that were explored were the digitalization of observation tools and implementation of a shared server that facilitates continuous sharing of information, as well as enhancing communication through the introduction of visualization tools. In addition, RQ3 was addressed by exploring the potential of telehomecare tools to provide patients with self-management and safety. Lastly, in order to prevent slow uptake and project abandonment, factors to enhance motivation for innovations such as alignment of strategy development and decision making were investigated. The analysis of the current situation laid the foundation for addressing RQ2 by exploring the solutions and goals that could be applied to achieve the desired state of home help service provision. This process was aided by the transformation of the goals and processes as well as the introduction of concepts and technological components to aid their achievement. The implications of preserving the patient's privacy and ensuring security facing the rapid digitalization of provision of care was also addressed.

To answer RQ4 and RQ5, a layered enterprise architecture inspired by the CityXChange architecture was explored and modified to fit the needs of the home help service provision. The main contribution to the architecture was the addition of the concept layer and the two stakeholder perspectives of environment and capabilities. Furthermore, technological solutions for supporting the privacy of patients and security of data were proposed in the data perspective. Finally, the enterprise architecture was applied to the desired situation to illustrate how it can be used to enhance the alignment of the enterprise and support efficiency in the home help provision.

By answering these five research questions, the thesis has explored central challenges to the home care service provision and how this can be addressed by facilitating interoperability and digitization with support from enterprise architecture and enterprise modeling. It has also proposed technologies to facilitate the transition from traditional institution-based care to home care as well as the tools necessary to protect the privacy of the patients and the security of the

data. Lastly, it has shown how a layered TOGAF architecture could be modified to integrate these solutions holistically. Thus, the results of this thesis provides a relevant contribution to the body of knowledge.

8.1 Future work

The provision of care for elderly patients in their homes is complex and there are a lot of factors that must be addressed to reach the optimal state of home care provision. A list of subjects that were deemed as out of scope for this research, but are still considered important for future work is presented below:

- Iterate the proposed architecture through the TOGAF ADM based on feedback from a broad spectrum of stakeholders such as health personnel, technical staff and patients.
- Expand on the secure aggregation of data through for instance the partitioning of servers.
- Expand the architecture to include more actors and organizational units, such as specialists and health stations.
- Explore the implementation cost of proposed technical components and compare it to the benefits of the function they provide.
- Implement logging and monitoring of information given over communication tools to provide quality assurance and accountability
- Discuss how dementia or mental health issues can influence the digitalization of home care provision
- Expand upon how to address timeliness and synchronization of information between actors in the system
- Expand and implement the specific technical components and their corresponding processes and services
- Explore ethics and philosophy surrounding the inclusion or exclusion of actors and technologies
- Expand on the requirements for a payment system and integrate it in the system (implementation)
- Explore the implications of storage and analysis of (potentially) huge amounts of sensory data from telehomecare tools and how to manage this.

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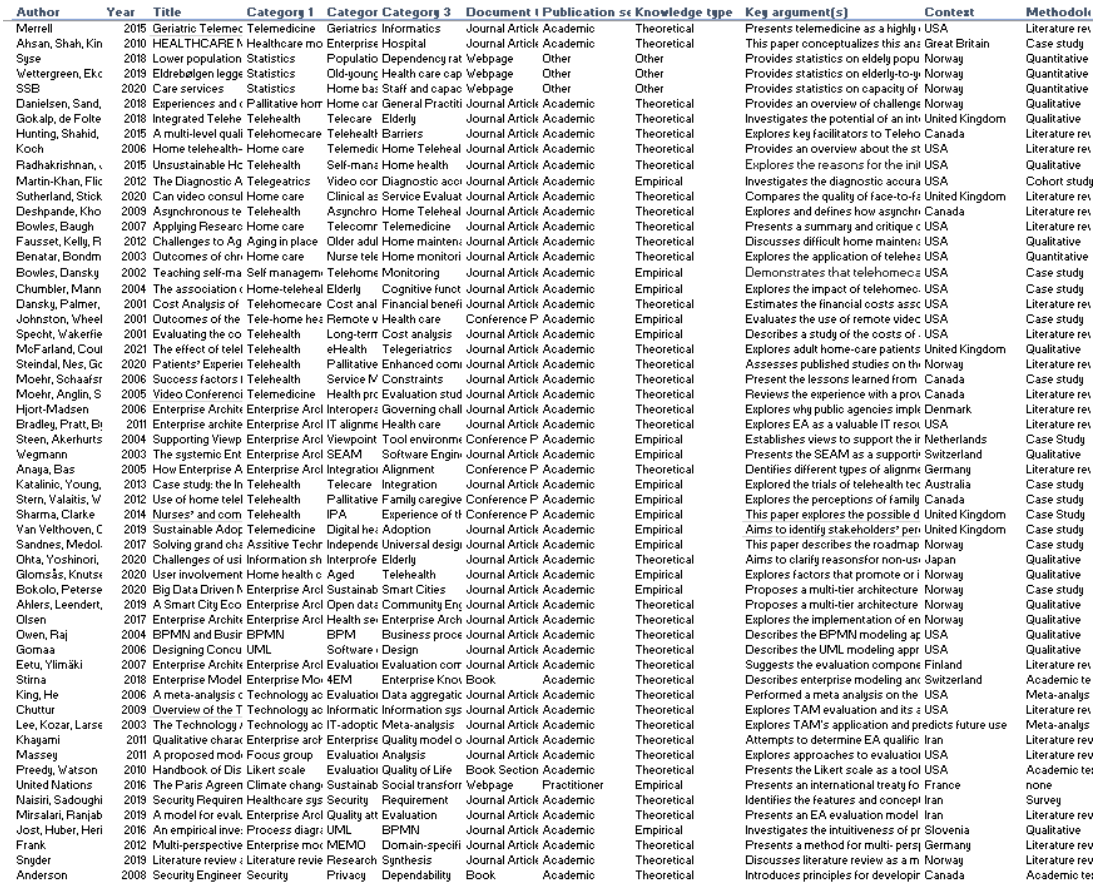
Appendix A Literature database

A.1 Complete literature list

All data sources relevant to the thesis, and that were read in full, are presented in Figure A.1 and Figure A.2. The list is exhaustive and not all data sources in it were ultimately used in the thesis. However, to ensure full transparency, they are included on the list. The information on the literature list includes the author, title, year, category (keywords) as well as what kind of document it is. In addition, the context (country) in which it was written and the methodology was included.

Author	Year	Title	Category 1	Categor	Category 3	Document t	Publication so	Knowledge type	Key argument(s)	Context	Methodol
Christensen, Har	2014	Analysis and desi	Software ecos	Third-part	Telemedicine s	Journal Article	Academic	Mixed	The usage of telehealth proves a p	Denmark	Mixed
Haghighathoseir	2018	Hospital enterpri	Hospital Orgin	Informatic	Enterprise archi	Journal Article	Academic	Empirical	Hospital infrastructure is highly co	Iran	Quantitative
Schooley, Hikme	2013	Design of an Ente	Electronic Pati	Emergenc	Pre-hospital to	Journal Article	Academic	Theoretical	Linking pre-hospital records to ho	USA	Survey, work
Bakar, Selamat, I	2017	Assessing the Ca	Enterprise Arcl	Balanced	Analytic Hierarc	Journal Article	Academic	Theoretical	Developing countries are lagging b	Malaysia	Case study
Virkanen, Mykkä	2014	Variability of ente	eHealth	Project lif	Traceability	Journal Article	Academic	Theoretical	Large-scale projects require gover	Finland	Case study
Costetchi, Mois	2013	Enterprise Archite	Service Archite	E-Healthc	Information sys	Journal Article	Academic	Theoretical	EA is the first step to getting the h	Romania	Mixed
Bakar, Selamat	2016	Investigating Ente	Balanced Scor	Configura	Central Sucess	Journal Article	Academic	Theoretical	A good EA must identify its centra	Malaysia	Case study
Finet, Gibaud, Da	2016	Relevance of hea	Document sha	Interopera	Domoplaie	Letter	Practitioner	Theoretical	Lack of interoperability is a probler	France	Literature re
Adenuga, Kekwa	2015	eHealth integratic	eHealth	Interopera	Enterprise archi	Journal Article	Academic	Theoretical	Technology is evolving at a very fa	South Africa	Literature re
Hussein	2017	The Promise of E	Global health a	Global he	EA and Global H	Journal Article	Academic	Theoretical	EA and GHI (Global Health Inform	USA	Literature re
Wang	2011	Enterprise Archite	Complex Large	Enterprise	Lean Advancen	Thesis	Academic	Theoretical	Compared CLIOS and EA and disc	USA	Literature re
Dorsey, Topol	2016	State of Telehealt	Telehealth	Limitation	Patient-Physici	Journal Article	Academic	Theoretical	Telehealth has several limitations,	USA	Literature re
Tuckson, Edmur	2017	Telehealth	Key trends of t	Telehealth	Implications for	Journal Article	Academic	Theoretical	To improve telehealth, key aspect:	USA	Literature re
Beaunoyer	2020	COVID-19 and dig	COVID-19	Mitigatior	Digital	Journal Article	Academic	Theoretical	Digital inequality enhances the soc	Canada	Literature re
Chehrehgosha	2020	The unpreparedne	COVID-19	Pandemic	Unpreparedness	Journal Article	Academic	Theoretical	The unpreparedness governments l	Iran	Literature re
Ting, Carin, Dzau	2020	Digital technolog	COVID-19	Digital To	Mitigation	Magazine Arti	Practitioner	Theoretical	New technologies (such as IoT) ca	Singapore	None
Bryson	2004	What to do when :	Stakeholder	Analysis	Identification	Journal Article	Academic	Theoretical	A good introduction to how to ana	USA	Literature re
Sessions, deVad	2014	A Comparison of	TOGAF	Zachman	VRF/SIP	Journal Article	Academic	Theoretical	A good overview of the history of	USA	Literature re
Petersen, Bach,	2010	Patient Care acrc	Enterprise Mo	Active Kn	Health Informat	Journal Article	Practitioner	Theoretical	Provides good methodology for d	Norway	Case study
Bellman, Griesi, I	2015	Agile Enterprise A	Enterprise Arcl	Assessm	Framework	Journal Article	Academic	Theoretical	A view of the traditional vs post-m	California	Literature re
Hämäläinen	2020	A Framework for	Enterprise Arcl	Framewor	Digitization	Journal Article	Academic	Theoretical	Explores how modern technology	Helsinki	Case study
Bokolo, Ahlers, I	2020	Big data driven m	Enterprise Arcl	Big Data /	Technology ma	Journal Article	Academic	Theoretical	Explores how a multi-tier architect	Norway	Case study
Petersen, Pourz	2019	Value-Added Ser	Enterprise Arcl	Data Spac	Smart Cities	Journal Article	Academic	Theoretical	Provides a good EAF based on a	Norway	Case study
Bokolo, Peterse	2019	Big data-oriented	Enterprise Arcl	Big Data /	Energy Informat	Journal Article	Academic	Theoretical	Provides a good insight in layered	Norway	(multi-)Case
Winter, Fischer	2006	Essential Layers,	Enterprise Arcl	Computer	Risk Analysis	Journal Article	Academic	Theoretical	Provides a good overview of a ger	China	Literature re
Ajer, Hustad, Vas	2019	Enterprise Archite	Enterprise Arcl	Health inf	Qualitative rese	Journal Article	Academic	Theoretical	Discusses several issues in the he	Norway	Qualitative
Ajer, Olsen	2020	Enterprise Archite	Enterprise Arcl	Digital Tra	Public Sector	Journal Article	Academic	Theoretical	Investigates challenges with EA in	Norway	Case study
Gunawan, Liejaya	2020	Formulating clou	Hospital Inforn	Enterprise	Zachman	Journal Article	Academic	Theoretical	Assess how the Zachman approa	Indonesia	Case Study
Purnawan, Suren	2016	Building Enterpris	Enterprise Arcl	Hospital Ir	TOGAF	Journal Article	Academic	Theoretical	Explore criteria for EA in the healt	Indonesia	Literature re
Sembiring, Nuryati	2011	Analyzing the Indi	Enterprise Arcl	Methodol	IS/IT Strategy	Journal Article	Academic	Theoretical	Extracted the basic functionalities	Indonesia	Qualitative
Wichmann, Wißo	2019	An Exploration of	Enterprise Arcl	Systemati	Hospitals	Journal Article	Academic	Theoretical	Provides a qualitative overview of	Germany	Literature re
Zanaboni, Fagerl	2020	Patients' use and	e-Health	Survey	Norway	Journal Article	Academic	Empirical	Provides insight in patients use of	Norway	Survey
Fossland , Krog	2015	Modeling As-is, C	Enterprise proc	Case stuc	Norway	Journal Article	Academic	Theoretical	Looks at how the current AS-IS to	Norway	Case study
Osei-Tutu, Song	2020	Enterprise Archite	Enterprise Arcl	Health Inf	Cloud Migratio	Journal Article	Academic	Theoretical	Explores how cloud computing ca	USA	Literature re
Pasaribu, Sipahu	2019	Designing Enterpi	Enterprise Arcl	Informatic	Medical admini	Journal Article	Academic	Theoretical	Proposes and architecture based	Indonesia	Case study
Malavolta, Lago,	2013	What Industry Ne	Software archi	Architect	ADL	Journal Article	Academic	Empirical	Provides a link between what the u	Italy	Survey
Direktoratet for e	2017	Nasjonal e-helse:	e-Helse	Digitaliser	Helse-og omsc	Other	Other	Theoretical	Provides the Norwegian governm	Norway	None
Direktoratet for e	2019	Plan for e-helse 2	e-Helse	Digitaliser	Helse-og omsc	Other	Other	Theoretical	Provides an update on the Norwe	Norway	None
Direktoratet for e	2020	Nasjonal e-helsep	Samordning	Systemint	Helse-og omsc	Other	Other	Theoretical	Provides a road map for better int	Norway	None
The Open Group	2018	About the TOGAI	TOGAF	Architect	Framework gui	Webpage	Other	Theoretical	Gives an introduction to TOGAF	USA	None
Zachman	2008	The Concise Defi	Zachman	Ontology	Framework gui	Webpage	Other	Theoretical	Gives an introduction to Zachman	USA	None
Petersen, Bokol	2021	D1.2: Report on th	Enterprise Arcl	CityXChai	ICT Ecosystem	Journal Article	Academic	Theoretical	Provides a framework for use in s	Norway	Case study, I
Camarinha-Matc	2004	Collaborative net	Collaboratory	Virtual ent	Virtual organiza	Journal Article	Academic	Theoretical	Explores a variety of collaboratory	Netherlands	Literature re
GDPR EU	2021	General Data Pro	Security	Privacy	Data governanc	Webpage	Other	Other	Rules for ensuring privacy and dat	Europe	none
World Health Org	2017	Integrated care fo	Inegrated care	Elderly	Caregiver supp	Journal Article	Other	Mixed	Guidelines on community-level int	Switzerland	none
World Health Org	2016	Multisectoral acti	Healthy aging	Home car	Sustainable lon	Journal Article	Other	Other	Vision, goals and strategic objecti	WHO	none
Noel, Ellison	2020	Inclusive innovati	Health innovat	Inclusion	Accessible des	Journal Article	Academic	Theoretical	Introduces the term inclusive inno	USA	Literature re
Gjertsen, Brønni	2018	Characteristics a	Hospitalizatior	Elderly	Assistive living	Journal Article	Academic	Theoretical	Reports on factors assosiated wit	Norway	Mixed
Gjertsen, Wiig, Te	2017	What are the key	Primary home	Elderly	Assistive living	Journal Article	Academic	Mixed	Identifies relevant contextual factc	Norway	Mixed
Gjertsen, Wiig, Te	2018	Health care persc	Community he	eHealth	Hospitalization	Journal Article	Academic	Empirical	Explores the attituted of health car	Norway	Qualitative
Wagnild	2001	Growing old at ho	Aging	Residents	Lifestyles	Journal Article	Academic	Mixed	Investigates the residental preferer	USA	Qualitative

Figure A.1: The collection of literature that has been read during this research



Author	Year	Title	Category 1	Categor	Category 3	Document t	Publication se	Knowledge type	Key argument(s)	Context	Methodol
Merrell	2015	Geriatric Telemec	Telemedicine	Geriatrics	Informatics	Journal Article	Academic	Theoretical	Presents telemedicine as a highly	USA	Literature rev
Ahsan, Shah, Kin	2010	HEALTHCARE M	Healthcare mo	Enterprise	Hospital	Journal Article	Academic	Theoretical	This paper conceptualizes this ana	Great Britain	Case study
Syse	2018	Lower population	Statistics	Populatio	Dependency rat	Webpage	Other	Other	Provides statistics on eldely popu	Norway	Quantitative
Wettergreen, Ekc	2019	Eldrebølgen legge	Statistics	Old-young	Health care cap	Webpage	Other	Other	Provides statistics on elderly-to-y	Norway	Quantitative
SSB	2020	Care services	Statistics	Home bas	Staff and capac	Webpage	Other	Other	Provides statistics on capacity of	Norway	Quantitative
Danielsen, Sand,	2018	Experiences and	Pallitative hom	Home car	General Practiti	Journal Article	Academic	Theoretical	Provides an overview of challenge	Norway	Qualitative
Gokalp, de Folte	2018	Integrated Telehe	Telehealth	Telecare	Elderly	Journal Article	Academic	Theoretical	Investigates the potential of an int	United Kingdom	Qualitative
Hunting, Shahid,	2015	A multi-level quali	Telehomecare	Telehealth	Barriers	Journal Article	Academic	Theoretical	Explores key facilitators to Teleho	Canada	Literature rev
Koch	2006	Home telehealth-	Home care	Telemedic	Home Teleheal	Journal Article	Academic	Theoretical	Provides an overview about the st	USA	Literature rev
Radhakrishnan,	2015	Unsustainable Hc	Telehealth	Self-mana	Home health	Journal Article	Academic	Theoretical	Explores the reasons for the init	USA	Qualitative
Martin-Khan, Flic	2012	The Diagnostic A	Telegeatrics	Video cor	Diagnostic acc	Journal Article	Academic	Empirical	Investigates the diagnostic accura	USA	Cohort study
Sutherland, Stick	2020	Can video consul	Home care	Clinical as	Service Evaluat	Journal Article	Academic	Theoretical	Compares the quality of face-to-fa	United Kingdom	Literature rev
Deshpande, Kho	2009	Asynchronous te	Telehealth	Asynchro	Home Teleheal	Journal Article	Academic	Theoretical	Explores and defines how asynchr	Canada	Literature rev
Bowles, Baugh	2007	Applying Researc	Home care	Telecomr	Telemedicine	Journal Article	Academic	Theoretical	Presents a summary and critique c	USA	Literature rev
Fausset, Kelly, R	2012	Challenges to Ag	Aging in place	Older adul	Home mainten	Journal Article	Academic	Theoretical	Discusses difficult home mainten	USA	Qualitative
Benatar, Bondm	2003	Outcomes of chr	Home care	Nurse tele	Home monitori	Journal Article	Academic	Theoretical	Explores the application of telehea	USA	Quantitative
Bowles, Dansky	2002	Teaching self-ma	Self managem	Telehome	Monitoring	Journal Article	Academic	Empirical	Demonstrates that telehomeca	USA	Case study
Chumbler, Mann	2004	The association	Home-teleheal	Elderly	Cognitive funct	Journal Article	Academic	Empirical	Explores the impact of telehomec	USA	Case study
Dansky, Palmer,	2001	Cost Analysis of	Telehomecare	Cost anal	Financial benefi	Journal Article	Academic	Theoretical	Estimates the financial costs assc	USA	Literature rev
Johnston, Wheel	2001	Outcomes of the	Tele-home hea	Remote v	Health care	Conference P	Academic	Empirical	Evaluates the use of remote videc	USA	Case study
Specht, Wakerfie	2001	Evaluating the co	Telehealth	Long-term	Cost analysis	Journal Article	Academic	Empirical	Describes a study of the costs of	USA	Literature rev
McFarland, Coul	2021	The effect of telel	Telehealth	eHealth	Telegeriatrics	Journal Article	Academic	Theoretical	Explores adult home-care patients	United Kingdom	Qualitative
Steindal, Nes, Gc	2020	Patients' Experie	Telehealth	Pallitative	Enhanced com	Journal Article	Academic	Theoretical	Assesses published studies on th	Norway	Literature rev
Moehr, Schaafsr	2006	Success factors f	Telehealth	Service M	Constraints	Journal Article	Academic	Theoretical	Present the lessons learned from	Canada	Case study
Moehr, Anglin, S	2005	Video Conferenci	Telemedicine	Health pro	Evaluation stud	Journal Article	Academic	Theoretical	Reviews the experience with a pro	Canada	Literature rev
Hjort-Madsen	2006	Enterprise Archite	Enterprise Arcl	Interopera	Governing chall	Journal Article	Academic	Theoretical	Explores why public agencies impl	Denmark	Literature rev
Bradley, Pratt, Bi	2011	Enterprise archite	Enterprise Arcl	IT alignme	Health care	Journal Article	Academic	Theoretical	Explores EA as a valuable IT resou	USA	Literature rev
Steen, Akerhurts	2004	Supporting Viewp	Enterprise Arcl	Viewpoint	Tool environme	Conference P	Academic	Empirical	Establishes views to support the ir	Netherlands	Case Study
Wegmann	2003	The systemic Ent	Enterprise Arcl	SEAM	Software Engin	Journal Article	Academic	Empirical	Presents the SEAM as a supporti	Switzerland	Qualitative
Anaya, Bas	2005	How Enterprise A	Enterprise Arcl	Integratio	Alignment	Conference P	Academic	Theoretical	Dentifies different types of alignme	Germany	Literature rev
Katalinic, Young,	2013	Case study: the In	Telehealth	Telecare	Integration	Journal Article	Academic	Empirical	Explored the trials of telehealth tec	Australia	Case study
Stern, Valaitis, W	2012	Use of home telel	Telehealth	Pallitative	Family caregive	Conference P	Academic	Empirical	Explores the perceptions of family	Canada	Case study
Sharma, Clarke	2014	Nurses' and com	Telehealth	IPA	Experience of th	Conference P	Academic	Empirical	This paper explores the possible d	United Kingdom	Case Study
Van Velthoven, C	2019	Sustainable Adop	Telemedicine	Digital hea	Adoption	Journal Article	Academic	Empirical	Aims to identify stakeholders' per	United Kingdom	Case study
Sandnes, Medol-	2017	Solving grand cha	Assitive Techr	Independe	Universal desig	Journal Article	Academic	Empirical	This paper describes the roadmap	Norway	Case study
Ohta, Yoshinori,	2020	Challenges of usi	Information sh	Interprofe	Elderly	Journal Article	Academic	Theoretical	Aims to clarify reasonsfor non-us	Japan	Qualitative
Glomsås, Knutse	2020	User involvement	Home health c	Aged	Telehealth	Journal Article	Academic	Empirical	Explores factors that promote or i	Norway	Qualitative
Bokolo, Peterse	2020	Big Data Driven M	Enterprise Arcl	Sustainab	Smart Cities	Journal Article	Academic	Empirical	Proposes a multi-tier architecture	Norway	Case study
Ahlers, Leendert,	2019	A Smart City Eco	Enterprise Arcl	Open data	Community En	Journal Article	Academic	Theoretical	Proposes a multi-tier architecture	Norway	Qualitative
Olsen	2017	Enterprise Archite	Enterprise Arcl	Health se	Enterprise Arch	Journal Article	Academic	Theoretical	Explores the implementation of en	Norway	Qualitative
Owen, Raj	2004	BPMN and Busir	BPMN	BPM	Business proce	Journal Article	Academic	Theoretical	Describes the BPMN modeling ap	USA	Qualitative
Gomaa	2006	Designing Concu	UML	Software	Design	Journal Article	Academic	Theoretical	Describes the UML modeling appr	USA	Qualitative
Eetu, Ylimäki	2007	Enterprise Archite	Enterprise Arcl	Evaluatio	Evaluation com	Journal Article	Academic	Theoretical	Suggests the evaluation compone	Finland	Literature rev
Stirna	2018	Enterprise Model	Enterprise Mo	4EM	Enterprise Knov	Book	Academic	Theoretical	Describes enterprise modeling an	Switzerland	Academic te
King, He	2006	A meta-analysis c	Technology ac	Evaluatio	Data aggregatic	Journal Article	Academic	Theoretical	Performed a meta analysis on the	USA	Meta-analys
Chuttur	2009	Overview of the T	Technology ac	Informatic	Information sys	Journal Article	Academic	Theoretical	Explores TAM evaluation and its a	USA	Literature rev
Lee, Kozar, Larse	2003	The Technology /	Technology ac	IT-adoptic	Meta-analysis	Journal Article	Academic	Theoretical	Explores TAM's application and predicts future use		Meta-analys
Khayami	2011	Qualitative charac	Enterprise arcl	Enterprise	Quality model o	Journal Article	Academic	Theoretical	Attempts to determine EA qualific	Iran	Literature rev
Massey	2011	A proposed mod	Focus group	Evaluatio	Analysis	Journal Article	Academic	Theoretical	Explores approaches to evaluatio	USA	Literature rev
Preedy, Watson	2010	Handbook of Dis	Likert scale	Evaluatio	Quality of Life	Book Section	Academic	Theoretical	Presents the Likert scale as a tool	USA	Academic te
United Nations	2016	The Paris Agreen	Climate chang	Sustainab	Social transforr	Webpage	Practitioner	Empirical	Presents an international treaty fo	France	none
Naisiri, Sadoughi	2019	Security Requiren	Healthcare sys	Security	Requirement	Journal Article	Academic	Theoretical	Identifies the features and concept	Iran	Survey
Mirsalari, Ranjab	2019	A model for evalu	Enterprise Arcl	Quality att	Evaluation	Journal Article	Academic	Theoretical	Presents an EA evaluation model	Iran	Literature rev
Jost, Huber, Heri	2016	An empirical inve	Process diagr	UML	BPMN	Journal Article	Academic	Empirical	Investigates the intuitiveness of pr	Slovenia	Qualitative
Frank	2012	Multi-perspective	Enterprise mo	MEMO	Domain-specifi	Journal Article	Academic	Theoretical	Presents a method for multi- pers	Germany	Literature rev
Snyder	2019	Literature review	Literature revie	Research	Synthesis	Journal Article	Academic	Theoretical	Discusses literature review as a m	Norway	Literature rev
Anderson	2008	Security Engineer	Security	Privacy	Dependability	Book	Academic	Theoretical	Introduces principles for developir	Canada	Academic te

Figure A.2: The collection of literature that has been read during this research

A.2 Statistics from literature review

In total, the literature review consisted of 110 data sources. Of these, 93 were published research articles, 5 were academic textbooks from the computer science studies, 7 were web pages and 3 were reports from the national directorate of e-Health. Lastly, there was a letter to gain insight in the interoperability and access to patient information and a magazine article describing the impact digitalization could have on COVID-19. None of these were used directly in the thesis since they did not meet the inclusion criteria, but the arguments they made were used as inspiration for further research on data sources that did. Thus, they are included in the full list to ensure full transparency. The distribution of data types can be seen in Figure A.3

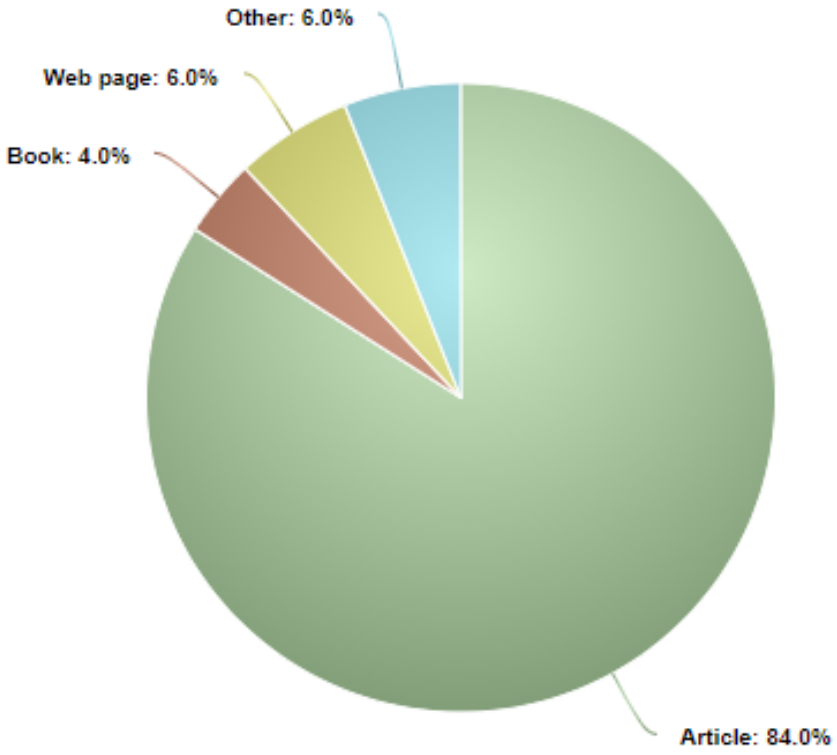


Figure A.3: The distribution of data source types

The oldest data source was from 2001 and the newest from 2021, with an average of 2014 over all 110 data sources.

From the 110 data sources, 81 were theoretical, 20 empirical and 4 mixed, as seen in Figure A.4.

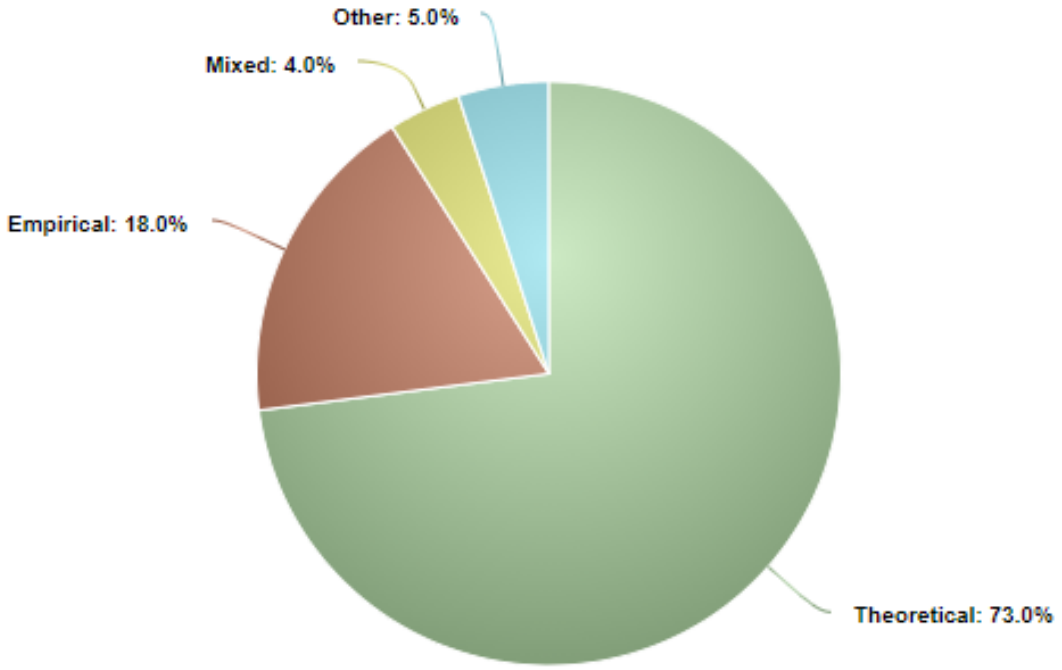


Figure A.4: The distribution of knowledge type

For context/country, the two main contributors were USA and Norway with 33 and 26 entries, respectively. The next two contributors are Canada and United Kingdom, both with 6 entries. The distribution of the top four contributors can be seen in Figure A.5.The fact that the country of which the service provision was examined is not the top contributor could be seen as a limitation. However, if data sources that do not directly relate to health care delivery are excluded the numbers drop to 20 for sources from USA, as illustrated in Figure A.6. In addition, the results from the American data sources are used for details on technology not specific to the provision of health care, interoperability or EA. An example of this could be the notation of BPMN and UML or information around the TAM-questionnaire and its use. On the other hand, the Norwegian sources acted as a basis for the solutions presented in the thesis and gave knowledge specific to the domain or technology used to enhance provision of care. Based on this, the results are therefore highly relevant to a Norwegian context.

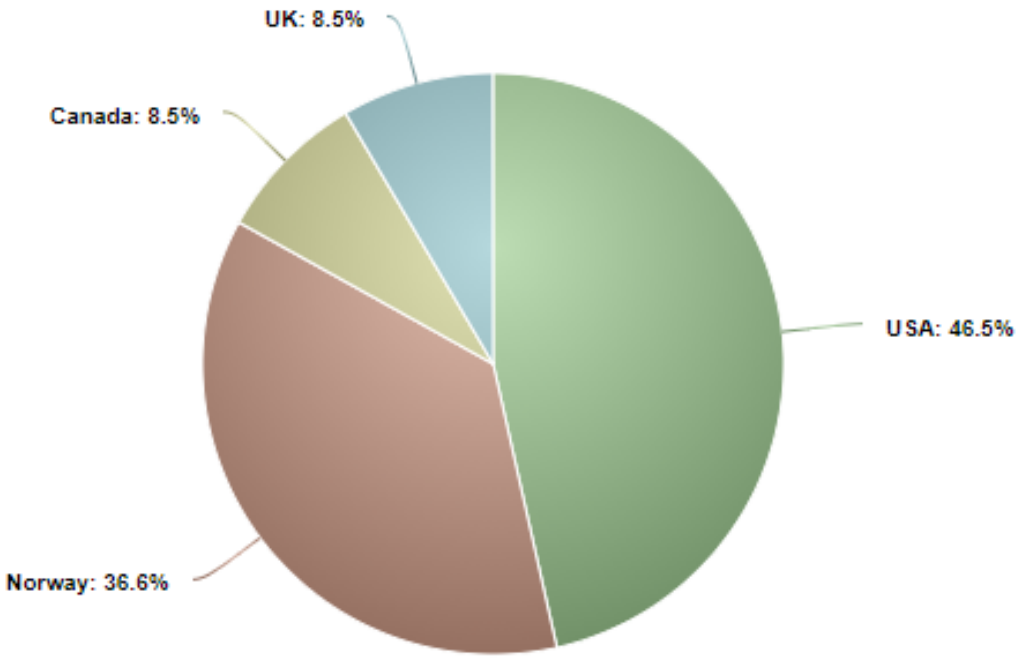


Figure A.5: The distribution of the top 4 countries that contributed

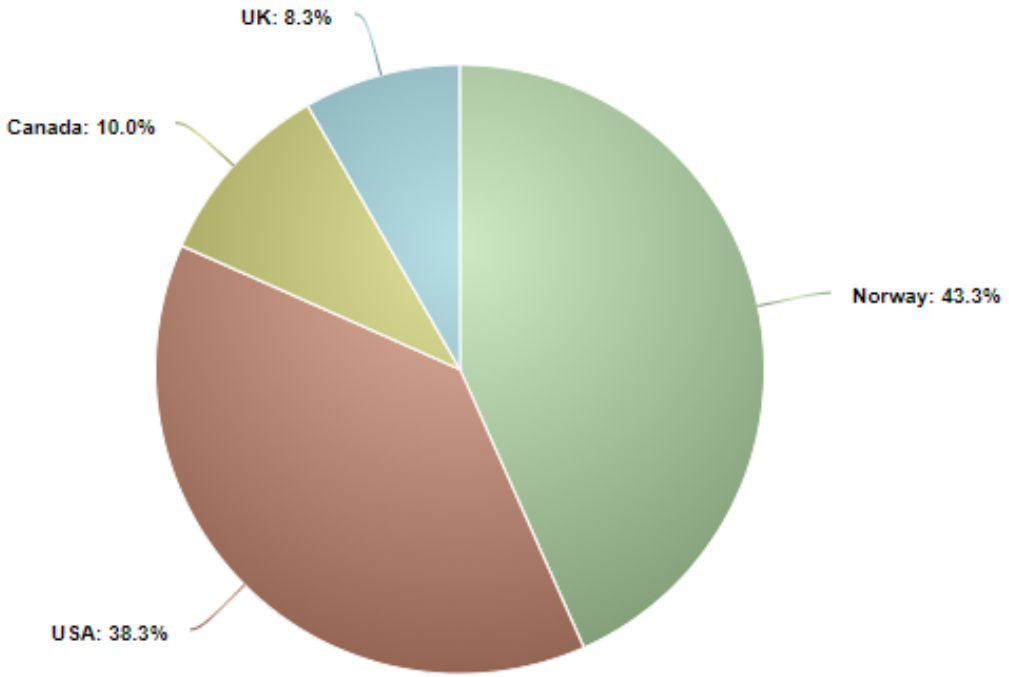


Figure A.6: The distribution of the top 4 countries that contributed, excluding sources not directly related to provision of care

Appendix B 4EM model notation

This appendix provides an overview of the notation of the 4EM modeling approach. All figures are taken directly from Sandkuhl et al.'s book on enterprise modeling[64].

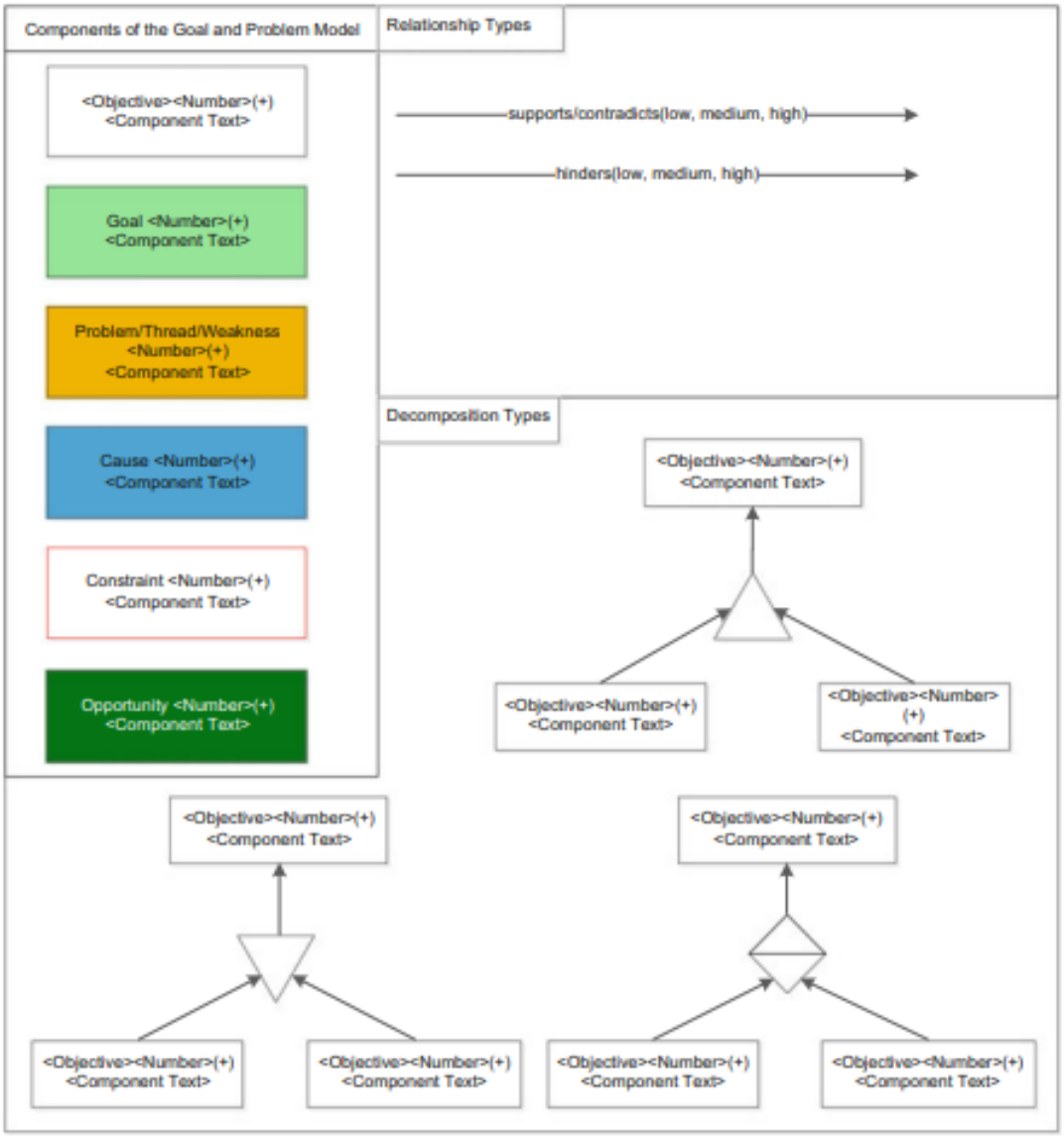


Fig. 8.11 Notation of Goals Models

Figure B.1: Goal model notation

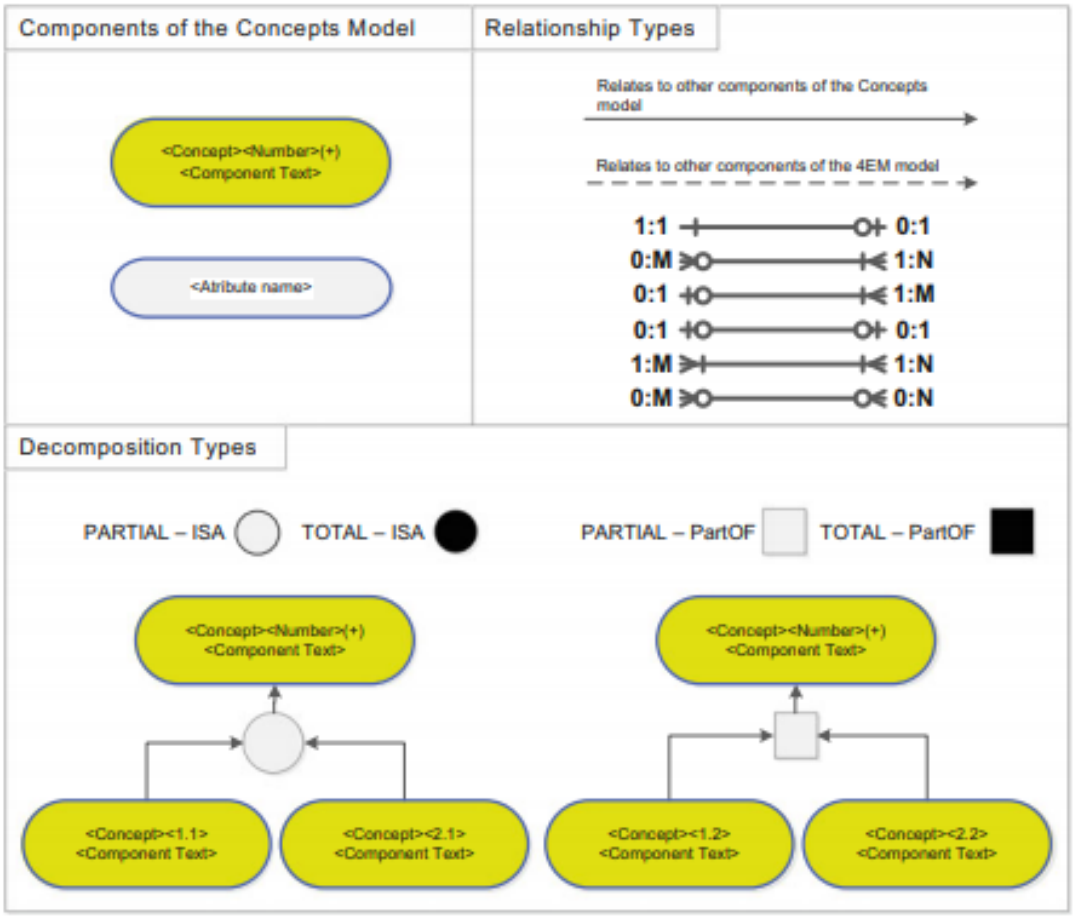


Fig. 8.35 Notation used for Concepts Modeling

Figure B.2: Concept model notation

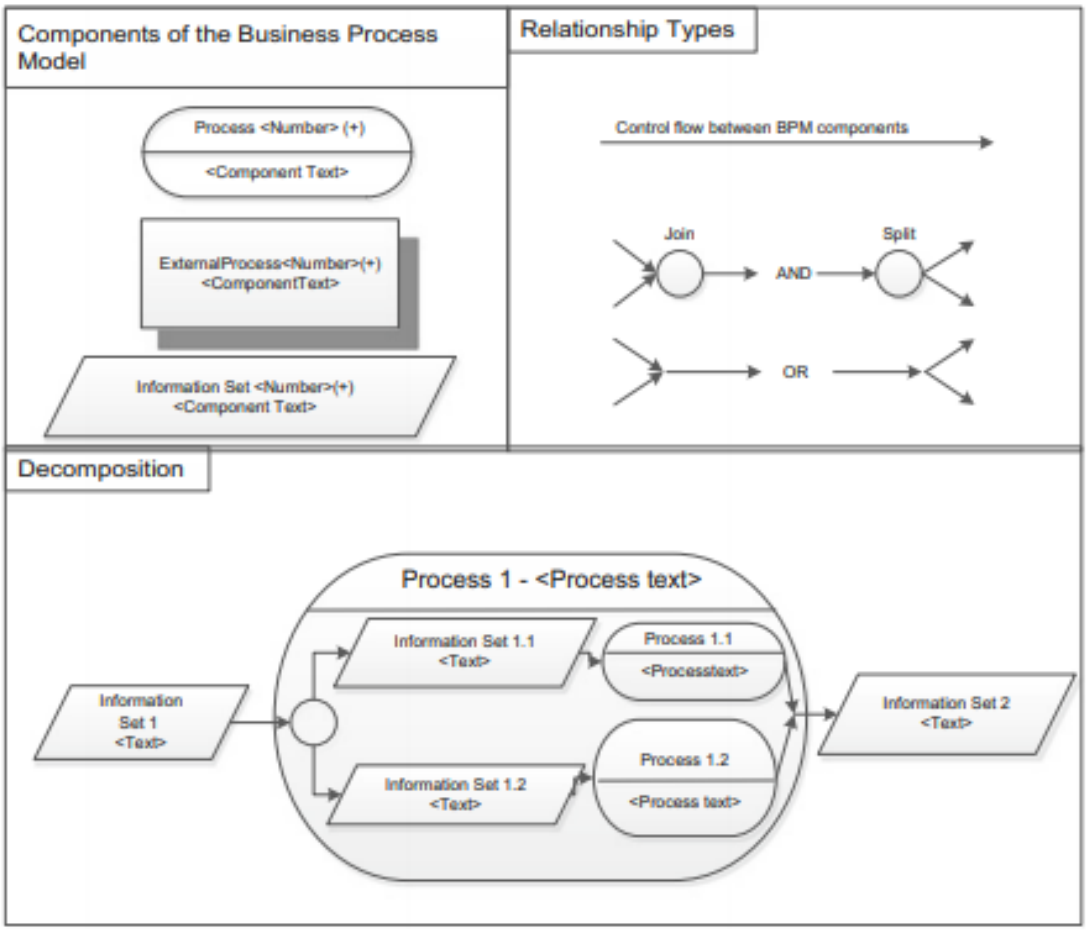


Fig. 8.40 Notation for Business Process Model

Figure B.3: Business process model notation

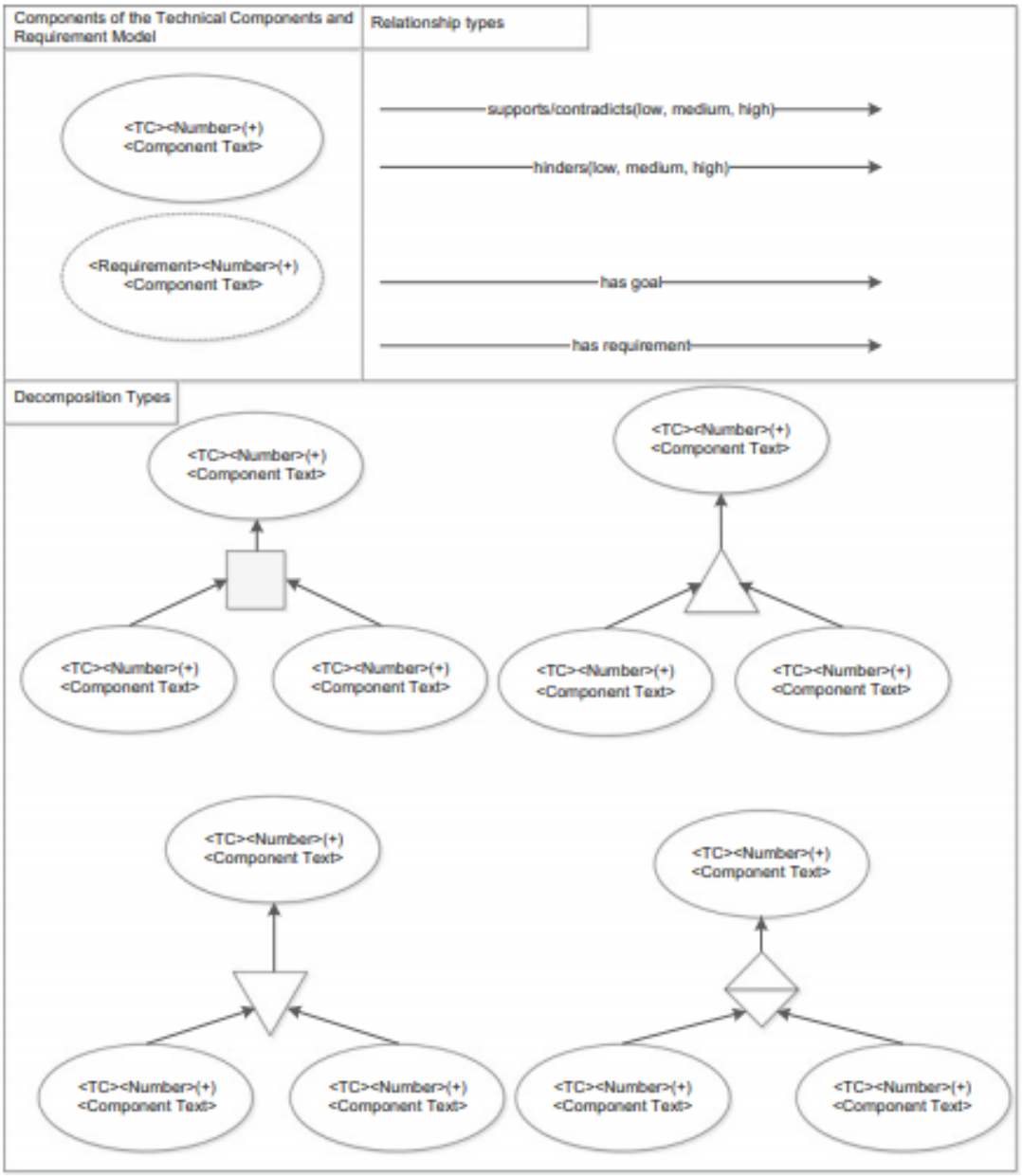


Fig. 8.54 The notation for the Technical Components and Requirements Model components

Figure B.4: Technical model notation

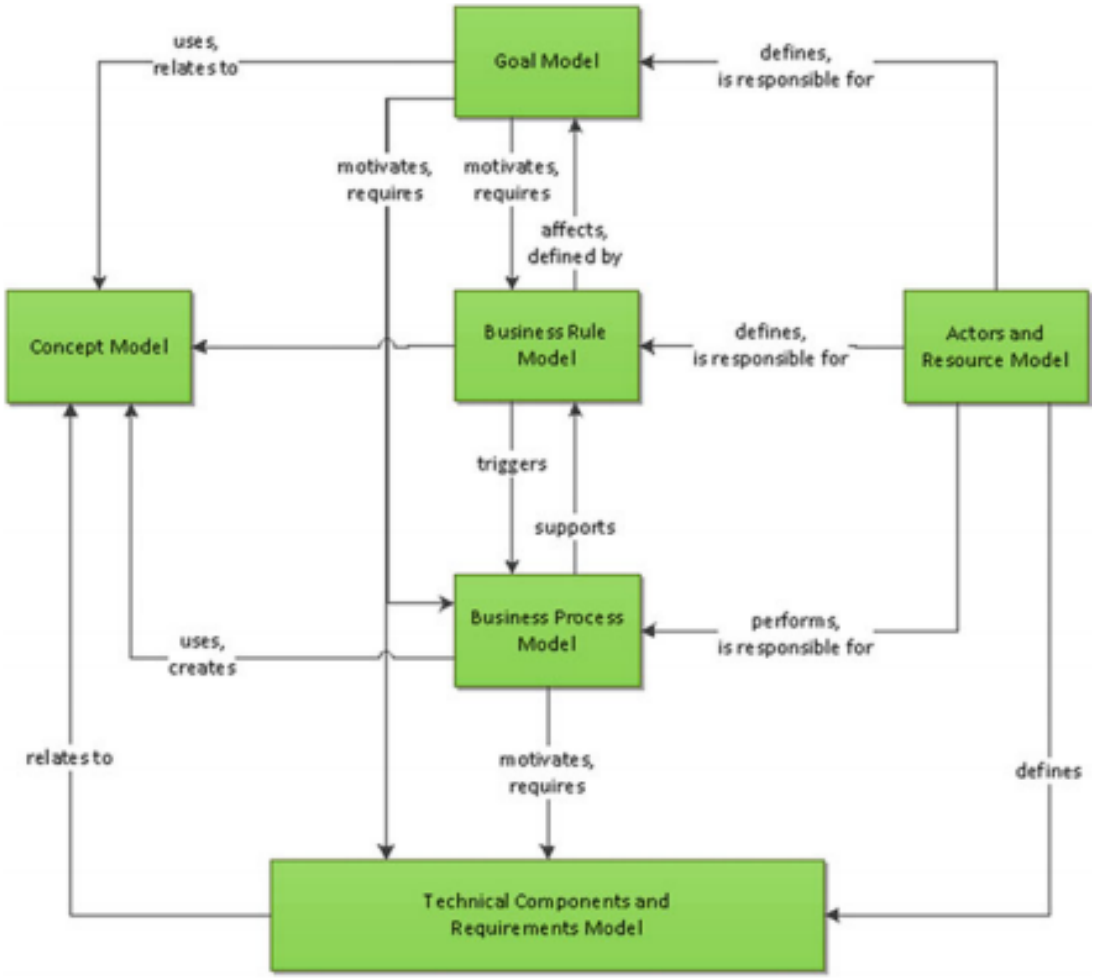


Fig. 8.60 Relationships between sub-models

Figure B.5: Relationships between the sub models

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