BACHELOR THESIS

IMPLEMENTATION OF SOCIAL SERVICE ROBOTS IN DUTCH HEALTHCARE

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Implementation of a social service robot in the Dutch healthcare system

A descriptive user analysis

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Abstract

Introduction Will robots be the healthcare workers of the future? In 2035 there will be a healthcare shortage of 135,000 by the year 2035 in the Netherlands. Improving the way innovative technologies are implemented in the Dutch healthcare system is a way to prevent the further decline of healthcare quality. This thesis aims to identify tasks that could be outsourced to social service robots (SSR) to mediate this worker shortage.

Method In this user-analysis, a multi-method review is performed combining literature, quantitative and qualitative review to identify several tasks that contribute to the workload and work intensity. For these reviews, a partnership with Landstede groep was effectuated.

Results Finally, these results led to the observation that mainly general daily life support (ADL care), housekeeping tasks, reporting and administrative tasks, daily structuring, and several peak activities yield the highest in workload and work intensity.

User-analysis and design requirements In conclusion, specifically housekeeping tasks, daily structuring, and several peak-intensity tasks were identified to be viable for adoption by SSRs. After this, a viability analysis using requirements determined by all three reviews was done, which showed which of these tasks were most viable and which still needed design improvements to be implemented. Especially housekeeping tasks were identified to be ready for implementation. Several design recommendations were made to make EVE more applicable.

Samenvatting

Introductie Worden robots de zorgmedewerkers van de toekomst? In 2035 wordt er een tekort van 135.000 zorgmedewerkers verwacht in Nederland. Door implementatie van zorginnovaties te verbeteren kan voorkomen worden dat de zorg in Nederland verder verslechtert. Dit proefschrift tracht de taken te vinden welke opgenomen zouden kunnen worden door sociale service robots (SSR) om dit zorgtekort te bemiddelen.

Methode In deze user-analyse wordt een multi-methode, bestaande uit een literatuur, kwalitatieve en kwantitatieve studie, gebruikt om een aantal taken te identificeren welke toevoegen aan de werkdruk en werkintensiteit. Voor deze studies is een samenwerking met Landstede groep bewerkstelligt.

Resultaten Uiteindelijke volgde uit deze resultaten dat met name het bieden van dag structuur, alledaagse levenshandelingen, huishoudelijke taken, administratieve taken en een aantal piekmomenten het meest toevoegden aan de werkdruk en werkintensiteit.

User-analyse and ontwerpeisen Er is geconcludeerd dat met name huishoudelijke taken, het bieden van dag structuur en een aantal piekmomenten mogelijk overgenomen kunnen worden door SSRs. Hierna is een vatbaarheidsanalyse uitgevoerd aan de hand van een aantal eisen welke opgesteld waren vanuit de literatuur en onderzoeksresultaten. Deze toonde aan dat met name huishoudelijke taken geschikt zijn voor implementatie. Een aantal ontwerpaanbevelingen zijn gedaan om EVE wijder toepasbaar te maken.

Contents

1 Introduction

For years the Netherlands has scored as one of the highest countries in terms of healthcare in the world ("Nederland scoort hoog in rapport Commonwealth Fund", 2021). Recently questions have arisen concerning the longevity of the healthcare system ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). As the population in the Netherlands ages and more people need healthcare, a decline in the quality of dutch healthcare is observed (Centraal Planbureau, 2022). This is because the amount of workers does not grow as rapidly as is necessary to uphold the current quality.

One of the ways to solve this shortage is by using the many technical innovations more prevalent in the healthcare sector. One of these technical innovations is the rise of Social Service Robots (SSRs)(Bemelmans et al., 2012). The usage of these robots could be the intermediary needed between the healthcare worker and the world of technology. NAKAMA ROBOTICS lab is a lab established in 2021 in partnership with the University of Twente. One of their aims is to develop one of these SSRs to facilitate this healthcare crisis.

The goal of this thesis, therefore, is to identify the tasks that could be taught to the SSRs in the healthcare sector, with the goal to mediate the healthcare worker shortage.

1.1 The current situation

The shortage of healthcare workers in the future is caused by two factors ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). The first of which is that the high healthcare standard that is prevalent in the Netherlands causes a higher life expectancy. People grow older and more diseases can be cured. Technology has always played a big role in healthcare. This leads to a shortage especially palpable in hospitals and elderly care.

This is also where technical innovations aim to make a significant difference. Not only in making the care more efficient and therefore allowing less staff to do the same amount of work but also by delegating some tasks currently performed by healthcare workers to these technical innovations.

SSRs could be applicable in this second method. Now, the important question that remains is, if SSRs are to be used in healthcare, what are the tasks that EVE-r3 would be able to do? And will that make a significant difference?

1.2 Goal of this study

The goal of this study is to conduct a user analysis on how an SSR (EVE-r3 in particular) can be applied in medical institutions to lower the current workload and what design requirements there are to make EVE-r3 more applicable. The belief is that the tasks that currently contribute to the workload will continue to do so in 2035 and that the most gain can be achieved concerning the negation of a worker shortage by resolving part of this workload. Another important aspect of this question is the role other medical technologies (MedTech) will play. Their influence on the healthcare system can not be ignored and should be taken into account when trying to observe the role SSRs will play.

Therefore, this goal is constituted of three different research questions: Where lies the highest workload and work intensity in the Dutch healthcare system. What developments in healthcare innovations are currently making a shift in regards to this workload and work intensity and finally, which tasks could be

done by SSRs. These three research questions will pose the answer to the main research question: What tasks should and what requirements should be set for an SSR to account for the shortage of healthcare workers.

1.3 Course of this investigation

To identify these tasks, the research phase compromises three distinct methods. The first is a literature review concerning workload and medical technologies (MedTech) in medical institutions. Then, a quantitative review to investigate the workload and physical intensity in various medical institutions. And finally, a qualitative review, that also investigates the workload and physical intensity in medical institutions, but also the viability of SSRs in these distinct healthcare sectors.

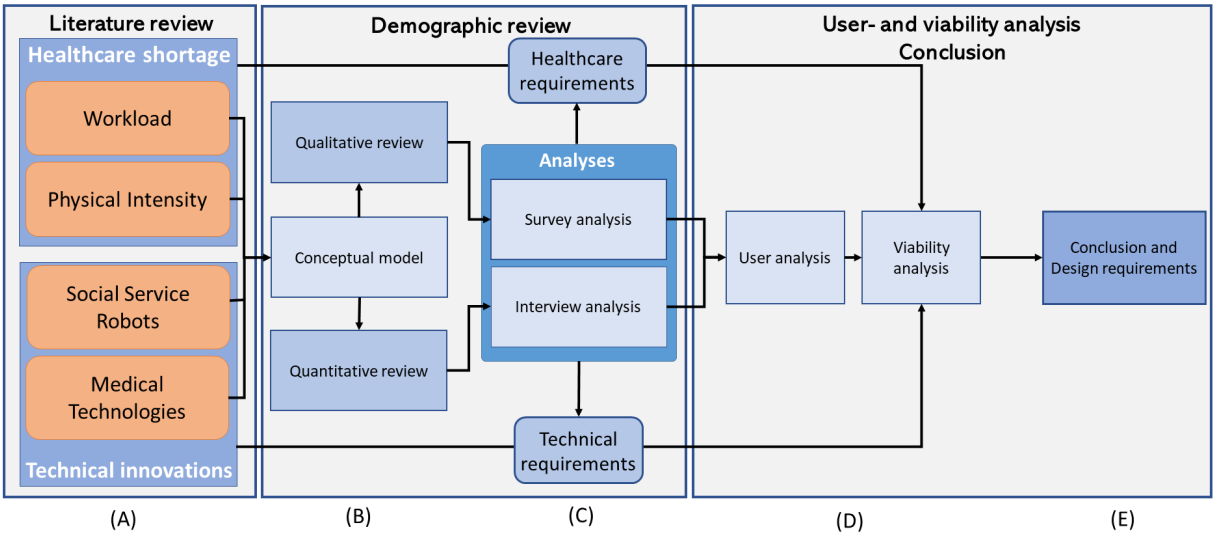
Finally, linking the results from these reviews in a user analysis. The tasks that were identified will be dissected into smaller sub-tasks. Technical capabilities and limitations of the robot platform will be determined, which tasks can realistically be supported by the robot platform. The robot EVE-r3 will be used as a basis for this analysis. Furthermore, design improvements for the robot are proposed for tasks that are not feasible to support with the current robotic device.

In conclusion, this thesis will offer an answer to the question: What tasks and consequential sub-tasks should EVE be taught to be applicable in health care? What design requirements can be formulated to make EVE more applicable in health care?

2 Method

In this chapter, the research design is discussed. First off, the chosen research strategy will be discussed and the decisions in regards to this will be explained. After this, the three research strategies will be explained and the basis for all three will be explained.

Figure 1: Research strategy



2.1 Research strategy

To systematically answer the research questions, a thorough understanding of the healthcare system is required. Therefore, the format of this research is determined to be multi-method. The broadness of the healthcare system warrants a research strategy that can yield the full diversity of its problems. Descriptive research is composed of multiple elements that yield this structural plasticity that is required (Doorewaard & Tjemkes, 2019).

Figure 2 shows the different phases in this thesis. (A) denotes the literature review. This review aims to set the boundaries within which the other two reviews take place. In order to correctly do this, four distinct subjects have been selected for the literary review. From these four subjects, a conceptual model is constructed, which yields the dimensions and topics upon which the qualitative and quantitative reviews were based. (B) Can be seen as the experimental phase of the demographic review. This encompasses the conceptual model and the two reviews that are based upon it. (C) This is the consequent analysis of these two reviews. This is also where the results of all three reviews come together into one bundle of tasks that are relevant for this user analysis. This bundle encompasses the distinct tasks that are viable to be taught to

SSRs. (D) This is where all information coincides with the user analysis. First, using the literature review, two types of requirements are formulated: The healthcare requirements and the technical requirements. The healthcare requirements are mainly based on the requirements set by the healthcare system. The technical requirements are mainly based on what should be possible in regard to engineering. Finally, a viability analysis is conducted, splitting the tasks up into sub-tasks and determining the implementation viability using the technical requirements and EVEs technical capabilities. (E) The results of this viability analysis will be concluded with the formulation of design requirements and the conclusion. Here, design requirements will be suggested and the conclusion will finalize this thesis.

2.2 Context and respondents

Encompassing a pivotal problem in Dutch society, this study is involved with multiple stakeholders. The primary group this study aims to include is the healthcare system. This is also the group which will denote the research populous. For the purpose of this inquiry the healthcare system is divided into four distinct groups. These groups are elderly care (ouderenzorg), disabled care (gehandicapten zorg), general hospitals (algemene ziekenhuizen), psychiatry (geestelijke gezondheidszorg) and at home care (thuiszorg).

Another important step in the selection of the research populous is the strategy of selection. For this purpose, an collaboration was formulated with Landstede groep. They are an education institution with multiple Intermediate Vocational Education (IVE) institutions in mid-Holland. Working together with a educational institution would allow more recipients and this would allow to branch out from one central point to the different stakeholders in the healthcare system. The assumption was made that using the connection with other education facilities would warrant a greater success rate, rather than trying to reach these stakeholders individually.

After selecting the research population, it is now important to select the tools that will be used to measure do the analysis. First of all, a literary review is done. This aim of this review was to set the context for the rest of the study, while simultaneously set a foundation for the user analysis to be based on. The second and third tool are a quantitative research and qualitative research. As the name suggests quantitative research entails a method of gathering information that can be applied broadly, to find as many respondents as possible within the scope of the subject (Doorewaard & Tjemkes, 2019). Qualitative research reaches a smaller amount of people, but tries to delve deeper into the subject than is possible using solely quantitative research (Ozawa & Pongpirul, 2013). It also aims get insight into the perception of technical implementations in the select healthcare branches.

2.3 Literary review

To start the process, a literary review was done. This review was split up into two distinct phases: healthcare shortage and technical innovations. The goal of this review was to get an understanding of where the healthcare system is being pressured the most and to get an understanding regarding the appliance of MedTech to counter this development right now. Online literature access websites such as ScienceDirect and Springer Link were used to look for articles relevant to this study. Strategic papers in regards to the healthcare shortage in general were also used for this review.

To determine which articles were relevant, two kinds of search mechanisms were used: filters and keywords. The filters that made sure that the general subject of the study was relevant to this field of study.

The key-words were the words that were used in the search bar to find the articles. The goal was to use key-words that were similar to the topics that were used in the qualitative and quantitative reviews.

In the following line-up below the used filters and key-words are denoted. The goal of using these filters and key-words was to get a condensed number of articles that would form the consensus around the theme of this paper.

In regards to the healthcare shortage:

- Healthcare
- Dutch healthcare
- Work load
- Work intensity
- Stress
- Shortage in elderly care
- Shortage in hospital care

In regards to Technical innovations:

- Medical innovations
- Humanoid robot
- social robot
- service robot

In order to find relevant results, these terms were used in combination between each other. The overlap between these two spheres gave the highest success rate of viability for this review. In order to get this overlap, phrases such as AND and OR were used.

Since these key-words and filters would also include articles that weren't of relevant to this study, a final check of inclusion was done. The abstract or summary was used to determine whether a article could be used. Articles were included if the summary gave an indication of the following topics:

- Workload, work intensity or stress in (Dutch) healthcare
- Decrease in quality of (Dutch) healthcare
- Medical innovations negate healthcare worker shortage
- The use of social service robots in (Dutch healthcare)

Or variations based on these factors. Other inclusion criteria were that the articles had to have been published between 1 January 2000 and 1 July 2022 and had to be peer reviewed. Other requirements were already reached through using ScienceDirect and Springr.

Since this thesis envelops a large societal issue, many sources were also selected from papers or reports published by or in coalition with the government.

2.4 quantitative research

The second tool was a survey that was both testing and exploring. Since the nature of Surveys makes them most applicable for testing studies about half the questions were, but for this descriptive study the survey was also exploratory. This was achieved by creating a survey that was in part composed of closed questions, where most closed questions were partnered with open questions that allowed for more exploratory results.

During the literary review, the context for this survey was composed. This context formulated the

dimensions and topics the survey will adhere to. Apart from this context, the quantitative and qualitative reviews both have a distinct research structure which will be constructed in chapter 4.

This system yields a number of questions that were used for the survey. To make sure that the survey would responded to by enough healthcare workers, the limit to the number of questions was set to twenty. Being composed of a mix of closed and open questions. The expected average time to fill in the survey was expected to be around seven minutes.

The survey was spread out using the contacts obtained from the ROC Landstede groep. This led to the survey primarily being spread amongst healthcare workers that had not been active in their respective workfields for a long time. The survey was released to about 500 people. Respondents had 21 days to respond, with a reminder being sent after 14 days. Microsoft Forms was used to gather the surveys, and respondents were only allowed to fill in the survey once.

Some questions that were vital to the overall analyses were made mandatory. Questions that were not considered vital to the results were allowed to have missing values. The survey is added in appendix 2.

2.5 Qualitative review

The third tool is an interview done with selectively selected healthcare workers. Verhoeven writes that qualitative research helps with giving meaning to certain responses and situations. This means that the results of this interview can be more exploratory and in-depth than the survey is going to be. This allows the interview to also go into future perspectives and how these healthcare workers feel in regards to SSRs and other MedTech.

The interview is constructed using open and personal questions and aims to find a broad scale of information. Interviewees that are selected will either be active in education. This yields a broader perspective since they encounter multiple healthcare workers from different branches. Or will be active as innovative instructors within their branch. This means that they will have a good understanding of what developments are currently going on in the healthcare sector in regard to the developing shortage. The way this quantitative review was constructed on the literature review is denoted in chapter 4.

2.6 Procedures and data-analyses

When processing the data from the surveys Microsoft Excel will be used. In order to do this, a code book will be created where the questions will be transversed into code and the items will be summarised into code.

During the literary review, several items were identified. These were used to create the survey and the interview. The way these were integrated into Microsoft Excel is shown in table 11. The way these questions were constructed is further elaborated upon in chapter 4.

Thereafter, the dimensions of the statistical results of the data will be discussed. Here, the average, median, mode, and standard deviation will be discussed (Bal et al., 2010).

The analyses of the information from the interviews will be done in the following steps. The interviews will be transcribed from speech to text by hand. Afterward, the transcription will be compared to the actual audio, in order to identify any discrepancies, which will then be corrected. Now there will be a data-analyses where every interview will be analyzed using the dimensions, topics, and indicators. Similar to the filters and keywords that were used in the literature review and to the topics that were used to create the survey.

Table 1: Code and question table for the survey

Code	Question
S1.121	Met welke doelgroep in de zorg werkt u?
S1.111	Wat is uw functie in de zorg?
S1.131	Hoe lang bent u al werkzaam in de zorg in het algemeen?
S1.132	Hoe lang bent u al actief in deze tak van zorg?
S1.141	Ik geniet van mijn werk (1= volledig onjuist, 10 = volledig juist)
S1.142	Ik vind dat ik nuttig werk doe (1= volledig onjuist, 10 = volledig juist)
S2..211	Ik ervaar tijdsdruk bij mijn werk (1-10)
S1.221	Huishoudelijke taken zijn een deel van mijn basistaken op een dag 1-10)
S1.223	Ik ben relatief veel met opruimen en het schoonmaken van de zorginstelling bezig (1-10)
S1.231	Ik heb gedurende de werkdag relatief veel professioneel overleg met mijn collega's (1-10)
S1.311	Ik ervaar mijn werk als intensief (1-10)
S1.312	Na mijn werkdag ervaar ik fysieke vermoeidheid/hinder door mijn werk als zorgmedewerker (1-10)
S1.314	Dagelijks zit er variatie tussen intensieve en rustige taken op een dag (1-10)
S1.315	Ik besteed X procent aan taken die ik als intensief zou beschrijven per dag (1 = 0%, 2 = 20%, 3=40%, 4=60%, 5=80%, 6 = 100%)
S1.331	Ik besteed veel tijd aan het verstrekken van medicatie (1 = weinig tijd, 10 = veel tijd)
S1.322	Ik besteed tijd aan het bieden van ADL zorg aan patiënten welke zij zelf niet (meer) kunnen uitvoeren (1 = weinig tijd, 10 = veel tijd)

In conclusion, summarising analyses will be created out of all the singular interviews. In case there are unintended catches, these will also be included and analyzed (Doorewaard & Tjemkes, 2019).

3 Literature Review

In this section, the results of the articles that are relevant to the subject of this report are discussed. The goal of this literature review is to give context to this study and to the qualitative and quantitative review. This literature review is split up into two distinct subjects: First, where in healthcare the shortage is most prevalent. Second, it aims to give an overview of how technology develops currently to solve the shortage problem and the status of SSRs that are currently in use. From this analysis a conceptual model will be constructed and a contribution to the healthcare and technical requirements which will be used in the viability analysis in chapter 8.

3.1 The wear and tear of the Dutch healthcare system

In 2035, there will be a shortage of about 135.000 healthcare workers in the Netherlands ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). In general hospitals and elderly care alone, this will amount to 98.000. The prognosis is that the number of elderly people will be doubled by 2041 (Centraal Planbureau, 2022). For a long time, the primary concern about the quality of healthcare is its expensive nature, but as the Corona crisis has shown ("COVID-19-pandemie vergroot tekort aan zorgpersoneel", 2021) us and new research suggests, a shortage in healthcare workers will also be a prominent threat to the healthcare system.

The fact that the healthcare shortage would form such a problem was denoted last year by the 'Wetenschappelijke Raad voor Regeringsbeleid' in the Netherlands ("Kiezen voor houdbare zorg. Mensen, middelen en maatschappelijk draagvlak", n.d.). On 21 January 2021, they published several prognoses in regards to the Dutch labor market, which showed the overall shortage of healthcare workers. In eldercare and hospital care, 750.000 healthcare workers are active, which denotes 59% of all healthcare workers. These two sectors will amount to 73% of the total shortage in 2031. This shortage is primarily caused by a shortage of nurses at the mbo- and hbo- education levels ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022).

Gupta analysts also did several prognoses in regards to which aspect of care contributes the most to the workload. In regards to hospital work, three prominent factors result in 59% of the total workload. Administrative en reporting tasks amount to 21%, direct care for patients amounts to 19%, and logistics amount to 19% of the total workload and work pressure ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). In elderly care the top factor also was administrative and reporting tasks, spouting 28% of the work pressure. Providing structure to the lives of patients (Daily structuring) amounts to 18% and tasks such as providing sanitary needs and food and drinks both amounts to 10% (**GustraSz**).

3.1.1 Workload and work intensity in healthcare

To combat the healthcare shortage, two distinct terms are relevant in regards to the specific tasks that pose the largest thread: Workload and work intensity. Workload denotes the tasks that are the most time-consuming and therefore add take away from the time healthcare workers have. Work intensity denotes the physical and mental strain of certain tasks. They have the largest impact on the vitality of healthcare workers, and therefore how long they are able to work in the healthcare sector. (Greenglass et al., 2003)

When the goal is to fight an upcoming healthcare shortage, it is vital to combat these two types of constraints, where a decrease in workload allows for a relative increase of tasks that can be done and where a decrease in physical and mental intensity allows workers to be active for a longer time in healthcare, be it work relatively longer hours or being more vital and effective in the healthcare sector for a longer time.

As was stated before, a healthcare worker shortage leads to a decrease in healthcare quality ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). When a shortage occurs, pressure points in the general workload get overexposed. More mistakes are made and tasks that warrant a certain amount of attention can not entertain that anymore. For instance, it was observed that a big contributor to workload is the distribution of medicine (Westbrook et al., 2011). This is also very sensitive to error (Kuppadakkath et al., 2022). A large contributor to these mistakes is the healthcare worker being distracted by other tasks or clients (Schroers et al., 2022). When a worker shortage occurs, this is first observed in the tasks that contribute the most significantly to the workload.

3.2 Technical innovations in healthcare

One of the major factors that could pose a solution to this healthcare shortage is Technical innovations in healthcare (MedTech). Three distinct methods were identified in which MedTech could help in resolving this shortage ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022). The first method is preventing the necessity of healthcare. Facilitating systems that prevent complications or help with early diagnoses that prevent more intense treatment. The second method is making the current healthcare systems more efficient. This would allow a smaller amount of healthcare workers to do the same work as is expected right now. Number three is the automation of administrative tasks, which form a major part of the daily tasks of healthcare workers. The third method aims to help with the longevity of healthcare workers. MedTech can resolve a lot of burdens. By resolving both physically and mentally intense tasks, the amount of vitally competent healthcare workers ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022).

Gustra analists conclude that modern MedTech can resolve a shortage of about 110.000 healthcare workers. However, this would warrant an implementation of these innovations that is fully optimized. This 110.000 is submersed into two distinct groups. A shortage of 26,000 can be nullified by applying MedTech in a way that prevents the necessity of healthcare. 84,000 of the shortage can be nullified by making healthcare more efficient so that a smaller group of workers can offer the same amount of care ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022).

There is a significant difference in the way the workload is split up between hospitals and elderly care, and therefore the way MedTech can be used to decrease the workload. The majority of gain in hospitals can be obtained by preventing the necessity of medical assistance at all, whereas the majority of gain in elderly care can be obtained by making tasks more efficient and decreasing the intensity of the tasks. In elderly care, most profit can be gained in regards to the way reporting and communication are done right now. Another major factor is the daily structuring of the patients. Finally, washing clothing, sanitary needs, and food play showed to be big contributors to the workload.

3.3 Appliance of technical innovations

In healthcare, there are a number of different MedTech that are identified. For the purpose of this review five different categories will be delved discussed, in order to identify the diversity of MedTech that could form the solution to this healthcare crisis. ("Uitweg uit de schaarste: over noodzaak en belofte van medische technologie in de aanpak van personeelstekort in de zorg", 2022)

The first that is identified is medical appliances and auxiliary appliances. These are concrete objects that help in diagnoses, monitoring, treatment en the care for patients. Instances from these appliances are hearing aids, smart bandage systems and MRI-scanners. These technologies physically add to and improve the efficiency of the healthcare system.

The second category that is identified is mobile communication. These MedTech make it possible for medical staff to talk with and monitor patients from a distance. Instances from these appliances are consultations that are online, monitoring of chronic diseases and consultations between healthcare workers. The primary use of this technology is to make healthcare more efficient and allow patients to be more autonomous for a longer time.

The third major category is the usage digitizing patient data. These appliances make it possible to digitally note patient dossiers and also make it possible for healthcare workers to do the reporting more efficient. Instances of this come down to online patient dossiers and speech-to-text reporting. These systems can play a significant role in the intermediary reporting on patients between healthcare workers.

The fourth major category is the usage of artificial intelligence and deep-learning in healthcare. These are technologies that aim to show certain human qualities, such as the ability to learn, analyse and reason. The goal for it's use is in diagnoses, creating chat bots and help in real-time prioritising and analysing of measurement inputs. This also allows for more efficient monitoring, but also allows for doing tasks such as entertaining clients, showing interest and estimating certain parameters through conversation with clients.

The fifth and final category is the internet-of-things. These are appliances that are connected using an internet connection with other appliances and allows these different appliances to communicate. Examples of this are biosensors, wearables and robotics. Sensors such as stress or fall sensors make the monitoring of patients significantly more efficient, where wearables allow pre-diagnoses to be a lot more efficient. Robotics allow for systems that can do certain tasks that would otherwise be done by humans. Using robotics, allows the carer to perform different tasks in the case of a worker shortage.

One major type of MedTech that does not fall into a single one of these categories, but rather can be placed in a multitude of categories at once is the humanoid-robot. A robot that shows human characteristics, but simultaneously has the benefits of robotics and deep-learning.

3.4 The rise of the social service Robot

The rise of social humanoid robots has been a prevalent one, ever since new deep-learning technologies and engineering have reached a level, where the applications of these technologies have been profitable (Zhang et al., 2022). In the last decade, robot automation has primarily been used in factories and environments that are not dynamic. Its rise in environments that are subject to change is prevalent (Bemelmans et al., 2012). For instance, serving robots are being used in restaurants and other catering businesses. In these situations, the robots are being taught the layout of the restaurant and the necessary movements required to be successful as a serving robot (Zhang et al., 2022). For instance, new robot teaching methods encompass

using artificial reality to demonstrate to the robotic system how to do certain actions (such as picking up a diner plate and bringing it to the customer) and afterward dividing these actions into smaller actions to fully teach a serving robot the vital skills that are necessary for a diner situation (Halodi robotics, n.d.).

Another rise of assistive robots is in language understanding in modern human language technology. Recent studies were done in regards to healthcare workers shortage and usage of assistive robots to help rehabilitation and assistive social robots (Bemelmans et al., 2012). The second group can be split up into two subgroups, the service robots, and companion robots. In this case, the companion robot doesn't only play a role in the physical health of the client, but a role in the psychological well-being. Socially Assertive Robots show a prevalent uprising and innovations regarding communication between robots and humans.

Especially in elderly care, the communication between robots and humans shows to be very important. For instance, the Ifbot is a communication robot that can react to spoken language and respond by asking questions (Kanoh et al., 2005). This allows elderly people to have basic conversations, which decreases the feeling of loneliness and allows healthcare workers to redact their attention to other tasks. More importantly, conversing stimulates the brains, and especially in oncoming dementia, this shows to be vital in allowing elders to be more autonomous. Another example would be Nodding Kabochan (Kang, n.d.). This endearing child-like robot was also designed to converse with and sing to older people, relaxing them and entertaining them.

A large number of reports show a positive effect in regards to the usage of SAR with elderly people (Tapus, 2009). Among others, the interactions with robots showed an improvement in mood, a decrease in stress level, more activity in the elderly, and increased social interactions. The researchers concluded that living with Nodding Kabochan might improve the cognitive function of an older person, allowing them to be autonomous for a longer time.

Not all elders show an interest in communicating with robots (Bemelmans et al., 2012). Some elders even showed an increased feeling of loneliness and did not want to communicate with the appliance at all. These reservations went away as the elderly people grew more used to the device, showing that another important aspect in elderly care is that patients need to be well informed about the interactions with these SARSs.However, this doesn't only account for the elders, as the healthcare workers need to understand the benefits of the robots as well, for them to effectively work with them.

As explained, SAR can be very helpful in assisting with elderly care. This way, healthcare workers are allowed to focus on singular activities, decreasing the workload, while patients still have personal attention and care. However, it is important to never let the robot be a substitute for human care.

3.4.1 The medical application of social service robots

Now, should we deploy social robots in a care setting? This question should be answered in two steps. The first one is policy-based and encompasses ethical and societal problems, whereas the second one should focus more on the engineering questions behind the usage of care robots. To answer the first question, one needs to fundamentally understand the reasoning behind what care is required and how decisions based on these requirements are made. The second question warrants a more engineering perspective on the current status of medical robots and what risks and limitations are encountered in that respect.

One of the clear advantages of having a robot help in healthcare is that decreases the workload of the human carer. This makes healthcare more efficient and also allows for a higher overall experienced

satisfaction in well-fare clients. However, major problems here regard the chance that carer-client relations would undergo. For instance, to what level would this further dehumanize the healthcare system and how can we ensure that the robot-human relations do not grow malignant over time (Sætra, 2020).

These arguments can be analyzed by looking at three aspects of care: *structure, process, and outcome*. The first of the three encompasses the overall organizational structure of the healthcare system. For instance, one development in the organizational structure of healthcare is that elderly people stay at home a lot longer than they would 15 years ago. The process encompasses all the means that are facilitated in the process of caring for healthcare clients. For instance, what techniques are used to diagnose clients and which processes are then used to do certain medical procedures. Finally, there is a focus on the outcome. This is the raw outcome of the healthcare provided and concerns itself with the quality and quality of life after the procedure.

When regarding the negative consequences, they are found throughout these three aspects (Sætra, 2020). First, it may lead to structural changes with fewer human beings and more machines. This change is only negative regarding the fact that the gold standard is, and will remain to be human carers. The second is the process of receiving care from a robot. This is fundamentally a societal one. People might consider being cared for by a robot to be insufficient, harmful, and dehumanizing. Finally, the negative aspect regarding the outcome might be that the client is diminished due to the effects of human-robot relations. If human contact is indeed a basic human need, the increased use of robots in care may lead to the deprivation of this fundamental need, which in turn leads to mental disintegration. It is therefore always important to reflect on these doom scenarios and incorporate these in the design requirements for the policy in which these healthcare robots are implemented, as well as the engineering requirements for them.

3.4.2 Capabilities and limitations of the robot-platform: EVE-r3

From a technical standpoint, most of the requirements that regard robot carers stem from the intended use. Since the goal of this report is to analyze the viability of EVE-r3 , this literature review will only go into the technical aspects of EVE-r3. In the user analysis, the capabilities of EVE will be compared with the identified tasks.

Eve is a robot of human size, with two LED screens that make up a face (Halodi robotics, n.d.). It uses a stereo microphone to hear its surroundings and has a speaker to communicate. It uses a high-resolution camera which it uses to interact with the environment.

Eve-r3 is a humanoid robot platform that has been designed from the ground up to facilitate the lowest simulation gap possible, to ease machine learning development. This makes it ideal to learn new tasks in diverse environments. It is capable of mobile manipulation, visual servoing as well as human-machine interactions. This makes it possible for EVE to do autonomous servicing, which could be vital when implemented in a healthcare situation.

The 24 Revo1 motors EVE use offer a payload at the end effectors of 15 kg/33 lbs when close to the center of gravity and 6 kg/13.2 lbs when extended (Halodi robotics, 2022b). The robot itself facilitates 23 degrees of freedom (Halodi robotics, 2022a). This includes mobility in the wheels, ankle, knee, hip, torso, and neck. Eve has two arms which have mobility at the shoulders, elbows, and wrist.

The end effectors used are the bebionic hands (Otto Bock Healthcare Products, n.d.). The general use of these hand prostheses are generally used by humans with amputated hands but are now attached to a EVE-r3 unit. The bebionic hand is capable of 14 different gripping options. It facilitates two positions for

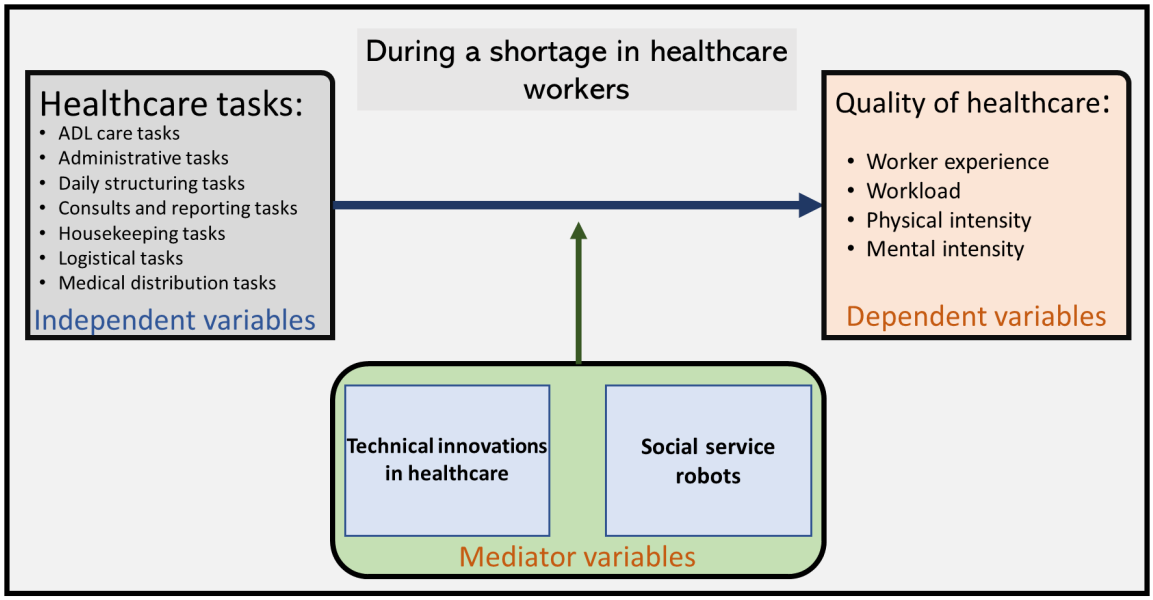
the thumb: opposed to the palm and in parallel with the tumb. When the thumb is opposed to the thumb, it can facilitate several different grips. These can primarily be used to hold things in the hand using the thumb as an obstruction, or do grip where the fingertip of the thumb and index finger meet. Instances of this grip are holding larger objects in the hand or holding objects between the fingertips. The other position allows for motions that use the thumb in a lateral position. Instances are the usage of a computer mouse or using keys to unlock things. The hand can be subjected to multiple forces. The following load limits are: a single finger of the hand can withstand 32 N and 44 N when the force is applied transversely. When the hand is closed it can withstand a force of 152 N.

Furthermore, EVE can be taught different tasks. The robot is equipped with a user computer that includes a GPU for inference computing while in use (Halodi robotics, 2022a). The Unity integration, allows the platform to train while in the cloud. This allows EVE to be trained using software, which makes the teaching of tasks a lot more efficient. However, before training via this method is done, one can do a risk analysis using three factors: Occurrence, severity, and detection (Kiran, 2017). The relation between these parameters can give insight into the risk that occurs when EVE is performing certain tasks.

3.5 Conceptual model

From this literature review, the context for the qualitative and quantitative studies can be derived. To determine the factors upon which these studies are based, a conceptual model is constructed. This model encompasses the most important abstract terms collected in the literature review and shows how they are connected setting the context for the following studies. The conceptual model is shown in figure 2.

Figure 2: Conceptual model



The independent variables in this model would be all the tasks that healthcare workers encounter but have for this study been reduced to the tasks contributing the most to the workload.

During a shortage, they impact the overall quality of the healthcare system. As was found in the literary review, this happens because the workload and work intensity are increased beyond levels that are sustainable for the healthcare system. Seeing as though the quality of healthcare is determined by the workload and work intensity, and they are in turn affected by the overall healthcare tasks, this makes these the dependent variables. It is important to note that the effect is greatly experienced when there is a shortage of healthcare workers present. Therefore, the scope of this study will be limited to that scenario.

Finally, the following studies will aim to determine the effect of certain medical innovations and the implementation of social service robots on the interplay between the independent and dependent variables. The reason both these innovations are named in the effect is that there cannot be a realistic determination of SSRs on this interplay, without also accounting to some extent for the other MedTech.

In conclusion, this also yields the following hypothesis which will be testing during the following studies:

> *SSRs can play a significant role in the correction correction of the increased workload and work intensity and decreased quality of healthcare, caused by the carer shortage.*

This hypothesis and the conceptual model will be used to erect the quantitative and qualitative studies.

4 Qualitative and quantitative review

Based on the on the literature review, the survey and interview can now be composed. The survey and the interview both have different qualities and weaknesses, which means that they have to be constructed bi partial to each other. They will be constructed using different core concept, dimensions and topics that are specific to the aim of their instigation. These will now be laid out in the following chapter.

4.1 Quantitative review: Survey

The survey is both testing and exploratory. It is the best at analysing the current situation. Which means it should be used to analyse the current effects of the worker shortage, based on the different tasks that were identified in the literature review. It will be doing this facilitating both closed and open questions.
Problem: In order to determine which tasks MedTech innovations could resolve, there should be an analysis into the workload and work intensity of the current healthcare system, in order to identify tasks that could be improved upon using technical innovations.
Central research question What is the relationship between the different healthcare sectors and the workload and work intensity they experience, how are these effected the different type of tasks they encounter?
Core subject Healthcare shortage.
Dimensions in the survey:
There are three dimensions to this interview:

1. Diversity between healthcare sectors
2. Workload
3. Work intensity

Topics in the survey per dimension:
Dimension 1: Diversity between healthcare sectors:

- Healthcare sector;
- Experience (both in general and with said target group);
- General quality of life in target group ;

Dimension 2: Workload analysis:

- Workload/time pressure experienced;
- Housekeeping tasks;
- reporting, administrative and consultation tasks;

Dimension 3: Work intensity analysis:

- Work intensity and physical intensity experienced;
- General daily care tasks;
- Distribution of tasks;

A number of questions where devised per individual dimension and linked to these topics. The questions and their responses are found in appendix 1.

4.2 Qualitative review: Interview

The quantitative reviews is primarily exploratory. Since it is exploratory and allows for a more in depth conversation with quality control through a more in depth selection of the interviewees, it can be used to research the current situation in regards to the shortage, MedTech and SSRs, as well as a future perspective in all these regards.
Problem: A user-analysis should be done with the goal to identify where in healthcare the workload and work intensity is most prevalent, what innovation are currently trying to solve these specific obstructions and whether a SSRs can be used for these tasks.
Central research question What is the relationship between the different healthcare sectors and the workload and work intensity they experience and could a humanoid robot be used to relieve stress in these tasks?
Core subject 1: Healthcare shortage, 2: Influence of technology on the healthcare shortage.
Dimensions in the interview:
There are five dimensions in the interview:

1. CS1: Healthcare sector;
2. CS1: Workload analysis;
3. CS1: Work intensity analysis;
4. CS2: Healthcare innovations;
5. CS2: Social service robots;

Topics in the survey:
DImension 1: Healthcare sector:

- Position in distinct sector;
- Healthcare sector;
- Experience in sector;

Dimension 2: Workload analysis:

- Housekeeping tasks;
- ADL care - Clothing ;
- Distribution of medicine;
- Reporting and consultations;
- Workload;

Dimension 3: Work intensity analysis:

- Daily structuring;
- ADL care - washing and clinically observing;
- Distribution of food and drink;
- Physical taxation;

Dimension 4: Healthcare innovations:

- What sort of innovations are currently being implemented;
- Future perspective of technology in healthcare;

Dimension 5: Social Service Robots:

- Experiences with robots in healthcare;
- Expectations of robots in healthcare;
- Reservations about robots in healthcare;

A number of questions where devised per dimension and linked to these topics. The questions and their responses are found in appendix 3.

5 Results

In this chapter the most important results of the survey and the interviews will shown. First, the quantitative and then the qualitative results will be discussed. But first, a pre-analyses compromising giving some context is given.

The general goal is to use the overlapping topics in all three methods to link the results and generally create a overlapping structure.

5.1 Demographic results

The survey was sent to about 500 healthcare workers, from which 87 responses were gathered. This means that 17.4% of people that received the survey responded to it.

On average, the survey took about 8:26 minutes to complete. This was slightly longer than intended, but not beyond bounds. There were no oddities in the number of time individuals took to fill in the survey. The missing values that occurred formed no obstacle in the analysis of the data. Most of the respondents were students, which allowed the level of pressure to be regarded as the same between individuals. At first, the goal was to make a distinction between experience/age groups, however, this was not necessary. 2 people were from other care branches than those mainly focused on. They were excluded from these results because their response did not offer new insights.

The interview was done with four people, each with experience in distinctive healthcare institutions: Handicapped care, Psychiatric care, elderly care, and general hospital. Two of the interviewees worked as innovation experts, and two also worked in education. The two working as innovation experts in their select

healthcare institutions were active in elderly care and handicapped care. One from the educative staff had experience in general hospitals, elderly care but primarily psychiatric care. The fourth interviewee was active as a healthcare worker in the ICU, as well as in post-surgery care and as an educator.

5.2 Results from quantitative review

Results from the survey. The results are shown more expensively shown in appendix 2. In this chapter, a summary will be given as well as the corresponding mean, standard deviation, minimum, maximum, median and modulus. These will be explored per topic, showing the results in regards to the individual healthcare branches. Regarding every type of task, there will first be shown how the distinctive healthcare branches scored in that regard, and then the tasks identified regarding that type of task are shown.

5.2.1 General hospital | Algemeen ziekenhuis

1.14: This group scored high on the questions regarding positive work experience. With only slight derivations. S1.212: Factors that create the highest workload are primarily the high amount of administration and reporting that is required. Then, consultations, ADL, and housekeeping tasks such as changing the beds and medication also scored high. The results show a discrepancy in the experienced workload, however, it does score high. Housekeeping scores the lowest of the tasks that affect workload. S1.313: Tasks that cause physical difficulty. In hospitals, this was mostly caused by a large amount of walking and ADL with patients that warrant heavy care. In other words, the logistics within hospitals and ADL care of care-heavy clients. On average, around 40-50% of tasks were described as being physically intense. S1.322: ADL tasks that take away the most time are washing, feeding, and performing care for patients. This especially occurs post-intensive care or post-surgery. S1.332/S1.334: when regarding housekeeping tasks, this comes down to disinfecting rooms. Cleaning in hospitals isn't done by nurses. BV1: It is also very mentally tiring.

Table 2: General hospital results

N = 10	Mean	St dev	Min	Max	Med	Mode
S1.141	7.78	0.833	7	9	8	7
S1.142	8.78	0.971	7	10	9	9
S2.211	7.78	1.20	6	10	8	8 7
S1.221	3.56	2.79	1	7	2	1
S1.311	8.11	0.782	7	9	8	8
S1.312	7.00	1.12	5	8	7	8
S1.314	7.56	1.13	6	9	8	8
S1.315	3.67	1.23	2	6	3	3
S1.331	4.67	2.29	1	7	5	7 6 5 1
S1.322	5.56	3.21	1	8	7	8
S1.223	3.89	2.47	1	7	3	7 2
S1.231	7.11	2.85	1	10	8	8

Table 3: psychiatric care results

N = 4	Mean	St Dv	Min	Max	Med	Mode
S1.141	7.25	0.500	7	8	7	7
S1.142	8.25	0.500	8	9	8	8
S2..211	5.75	3.20	1	8	7	7
S1.221	6.00	2.45	3	8	6.5	8
S1.311	6.25	2.87	2	8	7.5	8
S1.312	5.00	2.16	2	7	5.5	X
S1.314	7.25	2.75	4	10	7.5	X
S1.315	3.50	2.38	1	6	3.5	X
S1.331	5.67	3.06	3	9	5	X
S1.322	6.75	2.50	3	8	8	8
S1.223	7.00	1.83	5	9	7	X
S1.231	4.75	2.75	2	8	4.5	X

5.2.2 Psychiatric care | Geestelijke gezondheidszorg

S1.212: Factors that create the highest workload in this section are housekeeping duties and inexperienced personnel. This sector also scores relatively high in terms of workload. It does not score as high in intensity. S1.313: physically taxing tasks are housekeeping tasks and aggressive clients. There is also a level of mental strain. S1.322: Showering, washing, clothing, and sanitary tasks were identified as taxing ADL tasks. S1.332/S1.334: Cleaning, making the bed, taking out the trash, eating-related tasks, and doing laundry are taxing housekeeping tasks. BV1: Technology was mentioned as already making a great difference in regards to ADL. Medication rounds were also noted to be extra time-consuming.

Table 4: Disabled care results

N = 29	Mean	St dev	Min	Max	Med	Mode
S1.141	7.78	0.726	7	9	8	8 7
S1.142	9.73	0.917	8	10	9	10
S2..211	6.89	2.25	3	10	7.5	5
S1.221	2.78	1.90	1	7	2.5	1
S1.311	7.89	1.14	6	10	8	8
S1.312	6.89	1.46	5	9	7.5	8 6
S1.314	7.89	1.34	6	10	7.5	8 7
S1.315	3.44	0.76	3	5	3	3
S1.331	7.00	1.99	4	10	6	5
S1.322	8.00	1.47	5	10	8	8
S1.223	2.13	2.07	1	7	1	1
S1.231	5.22	2.50	2	10	4	4 3

5.2.3 Disabled care | gehandicaptenzorg

S1.212: The most time-consuming task in this category is reporting to clients' families other healthcare workers or doctors and housekeeping tasks. The results show that the experienced workload is high. S1.313: Tasks that cause physical difficulty. primarily the ADL tasks and housekeeping tasks. ADL scores are exceptionally high. S1.322: Taxing ADL tasks: Washing patients, cleaning, clothing, and showering them. Also, put on compression socks. S1.331: There is a high diversity in terms of the percentage of time spent on medication distribution. S1.332/S1.334: when regarding housekeeping tasks, this comes down to cleaning duties, doing laundry, and most eating and drinking-related tasks. Vacuuming and making the beds also scored high. BV1: It is also very mentally tiring, due to frustrations regarding the workload. Healthcare workers would rather work with patients rather than the endless reporting and housekeeping tasks.

5.2.4 At home care | VVT thuiszorg

S1.212: Factors that create the highest workload are the big amount of reporting that needs to be done. Also, in at-home care, the healthcare workers get a limited amount of minutes per client. This causes pretty much all tasks to be done under time pressure because unforeseen circumstances would cause over time. S1.313: ADL, traveling between clients, and showering the client were tasks that caused physical strain for the healthcare worker. S1.322: ADL tasks that caused workload were clothing, showering, and the general appearance of the client. Compression socks on pulling also scored high. S1.332/S1.334: when regarding housekeeping tasks, this isn't something that should be done by at-home care. However, sometimes they would help the client with cleaning the bathroom or doing favors. BV1: It was noted that there wasn't enough time for internal consultations between healthcare workers.

Table 5: At home care

N = 14	Mean	St dev	Min	Max	Med	Mode
S1.141	7.19	1.14	5	9	7	7
S1.142	8.51	1.18	6	10	8	8
S2..211	7.48	1.73	4	10	8	9 8 7
S1.221	6.65	2.59	1	10	7	7
S1.311	7.61	1.17	5	10	8	8
S1.312	6.39	2.43	1	10	7	8
S1.314	6.42	1.93	2	10	7	7
S1.315	3.45	1.09	2	5	3	3
S1.331	4.26	2.24	1	9	4	5
S1.322	5.48	2.43	1	9	6	3
S1.223	5.61	2.43	1	10	6	8 7
S1.231	5.77	2.31	2	9	6	8 7

5.2.5 Elderly care | VVT verzorgingstehuis

S1.212: Factors that create the highest workload are reporting, housekeeping tasks, distributing medication, and activating clients (daily structure). S1.313: The physical strain is mostly caused by ADL tasks. This is also because patients that go into elderly care continue to be worse off. S1.322: ADL tasks that cause workload and work intensity are transfers from beds to wheelchairs (or vice versa), providing food and drinks, showering, clothing, mobilizing clients, and helping put compression socks on. Distributing medication also scored high in workload. S1.332/S1.334: Housekeeping tasks encompass making the beds, general cleaning tasks, and laundry. Also doing the dishes passing and vacuuming. There was a high discrepancy found between the percentage of time carers spend on housekeeping tasks, as well as the experienced work intensity. BV1: One important factor of frustration is the lack of time for internal consultations between healthcare workers due to the high workload.

Table 6: Elderly care results table

N = 23	Mean	St dev	Min	Max	Med	Mode
S1.141	7.48	1.12	6	9	7	7
S1.142	9.07	0.997	7	10	9	10
S2..211	8.30	1.46	4	10	8	8
S1.221	6.85	2.31	4	10	6.5	4
S1.311	8.52	1.19	5	10	8	8
S1.312	7.41	1.99	3	10	8	8 7
S1.314	7.00	1.88	3	10	7	7
S1.315	4.19	0.74	3	5	4	5
S1.331	5.54	2.52	1	10	6	7 6 5
S1.322	8.07	1.47	5	10	8	9
S1.223	5.70	2.64	1	10	6	3
S1.231	5.59	1.91	2	8	6	7

5.3 Results from qualitative review

Using the labels that were introduced in the literature review and the method, the results and variables have been coupled to their respective dimensions. This summary will also be slightly analytical, to make the flow through the results more dynamic. An overview of these interviews is shown per dimension and topic in Appendix 4, which are the raw results.

5.3.1 Dimension 1: healthcare branch and expertise | Zorgtak en expertise

Topic 1.11/1.12: Four people were interviewed, and they were Experienced in four major healthcare branches. This denotes elder care and at-home care, disabled care, general hospital care, and psychiatry. Two of the interviewees are currently working in education, which constituted that they had a broader view of healthcare and experience in the education branch. Two other interviewees were innovation coaches in their respective branches, allowing them to have a more defined view of the prospects and needs of innovation within their branches. Topic 1.13: The primary disadvantages in all the different branches were regards to the high workload of reporting. Other intensive moments were identified as the eating moments in all branches. The handicapped and elderly care identified the general housekeeping chores to also contribute.

5.3.2 Dimension 2: Workload | werkdruk

Topic 1.21: When asked about the workload in regards to housekeeping chores, the chores regarding the feeding of the inhabitants were identified as a big peak moment. This was identified as a peak pressure moment in all branches. Topic 1.22: When asked about the workload in regards to activities of daily living (ADL) these tasks were identified as being the main contributors to workload in all branches. Specifically in elder and handicapped care with regards to the heavier clients that need more intense care. This is very reliant on the level of care that is required, as there is a lot of internal diversity between patients and conditions. Important to note in regards to performing ADL is that this is not excluded from performing ADL, but

also includes clinical observing and getting an insight into the quality of life of patients. Topic 1.23: When asked about the workload in regards to providing medicine to clients, handicapped and elderly care showed this to be very sensitive to errors. This was also identified as a peak moment in workload. In hospitals, this was mostly done using a certain medical procedure that warrants active time and attention. Topic 1.24: When asked about workload in regards to reporting and internal communication, handicapped care identified this as being around 60% of the workload. In elderly care, this was also regarded as extraordinarily high, especially because carers had to manually record these reports into the system. Topic 1.25: For general hospital care it was noted that reporting as well as ADL care is very diverse between patients. Thus, tasks that can generally be identified as having a high workload, do not constitute a high workload per patient.

5.3.3 Dimension 3: work intensity | werkintensiteit

Topic 1.31: When asked about the work intensity in regards to creating a daily structure for clients, handicapped care identified this as a large contributor to the overall work intensity. This is due to the large number of clients that are living in the living structure. Also, there is a large diversity between handicapped clients and their autonomy. One vital characteristic of this branch of care is the regain of autonomy, which is very client-specific. This was also identified in regards to elderly care, where patients must stay autonomous as long as possible. Topic 1.32: When asked about the work intensity in regards to ADL tasks such as washing and clinically investigating clients, this was identified as a vast factor in regards to intensity. This also contributed to the general workload, as this task increases with every patient. Especially incapacitated or heavy clients contribute to the intensity of these tasks. Another important factor is that most clients warrant this care at the same time. Topic 1.33: when asked about the work intensity in regards to distributing food, this was identified as a peak moment in the work intensity. Especially when a large group needed to get access to food this was a significant factor. Topic 1.34: When asked about work intensity in general, the response was that this is primarily caused by ADL tasks with clients that warrant a high level of care. Such as clients in a wheelchair or clients that had just been operated upon. It was also noted that elderly care is becoming more intense overall, since this group is expanding.

5.3.4 Dimension 4: healthcare innovations | Zorg innovaties

Topic 2.11: When asked about the current innovations of MedTech in their respective branches, handicapped and elderly care both eluded to the use of smart sensors and stress detection. This allowed for more efficient use of the workforce, and also allows for a higher quality of care for patients. In both branches, they had experience using a robot that helped with entertaining the clients in times of Covid-lockdowns. In elderly care, a pilot was being done on a speech-to-text reporting system. In regards to the hospital, the primary application is cameras, some smart-sensors, and hoist systems. This is apart from the wide scale of diagnostic systems that are present in hospitals. Topic 2.12 When asked about how they see the application of Medtech in the future, the four branches of healthcare gave the following answers. When asked in regards to housekeeping, the task of serving a lot of food should be automized. This would reduce a lot of the work pressure that occurs during this intensity peak moment. The analysis was that household tasks keep the worker from their 'actual' duties, so delegating this or making this more efficient would benefit the overall workload. When asked in regards to ADL tasks, this was primarily in regards to relinquishing the physical strain in these tasks. Facilitating systems take away the heavy tasks of hoisting heavy patients. When

asked in regards to medicine, the automation of this task was also identified as a development. Especially in regards to the at-home care that is becoming more prevalent. When they were asked whether they thought MedTech would be the primary solution to the healthcare worker shortage, they identified that making the current healthcare system more efficient would yield the largest gain.

5.3.5 Dimension 5: Humanoid robots | Menselijke robots

Topic 2.21: When asked whether their institutions had any experience working with humanoid robots, only the interviewee from the general hospital stated that they had never worked with a robot. The robots that were used were primarily socially assertive. Robots that allowed clients to communicate with people, yielded daily structure (reminding to the use of medicine or purely entertainment). Overall, the clients reacted very well to the SARs that were used. The healthcare workers had a harder time using the robots, due to technical difficulties. Topic 2.22: When asked which tasks they would see humanoid robots do in the future, they mainly identified tasks in regards to yielding daily structure for patients; entertainment, and reminders in regards to medicine or suggesting actions. In combination with smart sensors, these robots could hypothetically perform better at analyzing group dynamics or individual dynamics. Housekeeping tasks could also be delegated to humanoid robots, allowing healthcare workers to focus more on the ADL or other mandatory tasks. Also monitoring clients in situations where there are not enough healthcare workers to do so.

5.3.6 Dimension 6: By-catch | Bijvangst

Topic Bv1: One important piece of information that was gathered is in regards to the changing nature of the Dutch healthcare system. Healthcare is primarily focused on creating autonomy for clients and will use technology to achieve this goal. This means that patients will stay at home for increasingly longer times. Mainly as long as is physically possible. This means that elderly care and handicapped care will increasingly become more similar in the scale of their necessities. Namely, a vast increase in the severity of ADL care will occur. At the same time, at-home care will grow significantly, as also the need for helping these clients with their daily structure. Important in this regard is to keep in constant feedback with the carers, to know whether healthcare technologies are still up to standard. One way to solve this is by making technical innovation experts mandatory in hospitals, whose purpose is to innovate the hospital accordingly.

Another important point is that healthcare workers want to offer care. They don't go into healthcare to work with technology. Therefore, the usage of the technology should be as attainable as possible for healthcare workers. Also, it's the primary goal should be to make the work of the healthcare worker more efficient and easier, for them to understand its purpose. It could also be used to negate tasks that stand in the way of healthcare workers offering aid to clients.

The way the robot looks is also very important. When used in a socially interactive case, which is almost always the case in healthcare, it should not be intimidating in any way but should be endearing. In other words, it should more follow the dimensions of a pet than a human.

6 Analyses

The conceptual model that was constructed during the literature review has been researched using a quantitative and qualitative review. The results from these reviews have been summarised in the last chapter and now several conclusions will be drawn from these results. Upon these conclusions, the final user analysis will be based.

6.0.1 Survey analysis

The quantitative review illustrated a barrier between three types of healthcare institutions. Short-term, long-term, and at-home care. Short-term entails all general hospitals, long-term entails all institutions where patients live for a longer time and at-home care is healthcare provided at the client's house.

Short-term healthcare has a high turnover of patients, has a high workload in regards to clinical observations, and has many logistics-related problems. On the contrary, because patients stay for a shorter amount of time, housekeeping tasks and ADL tasks can be distributed either to cleaners or don't pose as much of a problem. This is because the severity of the warranted care diverse immensely among patients.

Long-term healthcare (elderly, handicapped, and psychiatric care) show that the highest workload and work intensity are found regarding ADL care, housekeeping tasks, and activating the clients in their daily activities (daily structuring). Especially ADL care is growing in severity because patients that are now added to long-term care are worse off.

At-home care is the group that is expected to grow the most. The cause of workload and work intensity in this branch is mostly caused by the structure of the way this care is distributed. Time pressure is high, which causes every individual task to have a higher workload.

6.0.2 Interview analyses

The primary cause for workload in the handicapped care branch can be denoted as ADL care, daily structuring, and increased administrative tasks. Big peak intensity moments are regarded as the medication rounds and eating moments with large groups. It is not possible to determine exactly how this workload is divided, due to the immense diversity between patients in this branch. This branch is primarily focused on making clients more autonomous and coaching them toward living by themselves. The expectation is that technology can play an important role in this, as long as it is implemented on a personal level. Technologies such as Google Nest Hub can significantly make this form of care more efficient and will yield more autonomy to patients. The handicapped branch will shift toward more autonomous at-home-based care, however, due to the diversity between clients, there will also be a large portion that remains in group homes.

When regarding elderly care the primary cause of workload is due to ADL care, daily structuring, and administrative tasks. However, it is known that over time this branch will grow to be much more at-home-focused. This suggests that the necessity of care will much more shift toward intense ADL care, and less to daily structuring, as the clients, will continue to grow less autonomous. As aging increases, the amount of ADL work per individual healthcare worker will also increase, creating a need for technological innovations that can negate this intensity.

When regarding the general hospitals, the largest amount of workload was regarded in logistics, the dispersing of medicine en administrative work. The highest work intensity was found in ADL care (primarily

at the ICU) and the high amount of walking and standing. Technology was said to not be implemented enough to counter the high workload in regards to logistics and administrative works.

When regarding at-home care the highest workload was identified in yielding daily structuring to the individual people. Technology can play a big part in terms of communication and helping the people living at home get more daily structuring. This will help the elder life an autonomous life for a longer time and keep them healthy for longer, and this will help handicapped people gain autonomy and control of their lives. Something food and deliveries.

Another factor that is important in elderly care is that multitude of tasks are performed simultaneously. For instance, when a patient is being washed and clothed, the healthcare worker is also checking the vital bodily working and doing prognoses in regards to skin.

6.1 In general

In summary, the highest contributing tasks in terms of workload and work intensity difference between the healthcare sectors. For long-term care institutions: The main contributor to workload is the ADL care during the morning and evening, the housekeeping, and the high amount of reporting and administrative tasks. Also, several peak intensity tasks such as the eating moments contribute heavily to the workload. In terms of work intensity, this is primarily caused by the ADL tasks and housekeeping tasks. This is similar to the short-term care institutions, however here logistics causes more of a problem, whereas housekeeping is not an issue.

One important conclusion is that the healthcare worker remains the gold standard for healthcare in the Netherlands. The greatest contributor to the workload and work intensity in long-term care institutions is ADL care. Healthcare will grow to be more at-home-focused, resulting in an even larger increase in the ADL workload in healthcare institutions. At the same time, elders and disabled people will be encouraged live more autonomously. Another positive about these items is that negating housekeeping tasks and logistics allows for an uptick in quality for the other tasks, such as ADL care

The autonomy of the client is also a very important takeaway from this analysis. In tomorrow's healthcare system, patients in all branches will be encouraged to live as autonomously as possible. MedTech that enhances this possibility will therefore be the most effective. On the other hand, SSRs that are implemented in healthcare institutions will have to work mostly by themselves with as little external guidance as possible. This is because healthcare workers will not work with technology that they think increases their workload rather than reduce it. This will however take some time before realization.

In a lot of ways, the MedTech that is currently on the market can resolve the identified workload. An important distinction has to be made between general technical innovations and social care robots: technical innovations could help make ADL tasks less cumbersome, make the high amount of administrative tasks more efficient and allow at-home care to function in a better way yielding autonomy and still keeping the healthcare worker in mind. Humanoid carer robots could make a difference in regards to the housekeeping tasks, helping with daily structuring for patients, and helping with the peak intensity moments: medication distribution and group diner sessions.

7 User Analysis

Now that the three research questions have been answered, the coming two chapters will work toward resolving the main problem of this thesis. The primary goal of this thesis is the identification of tasks that an SSR can perform. In this chapter, the results will be used for a user analysis of the reviewed healthcare sectors in order to identify these tasks. In the analysis, a number of core contributors were identified. These will now be used to identify singular tasks and their consequential sub-tasks.

7.1 ADL tasks

As has already been noted, ADL care is the highest contributor to the physical intensity in healthcare. When regarding the technical requirements, it must be concluded that these tasks are unfit to be taught to an SSR.

During the analysis, it was observed that these tasks are not only meant to do their primary goal but also serve a multitude of extra goals. During the washing and clothing of a patient, a patient is also checked for bedsores and diverse other conditions. Also, the way these tasks should be performed differs per individual, so the unpredictability of humans is most prominent in these tasks.

Furthermore, there are other MedTech that do yield the reduction in intensity that is warranted for ADL. Therefore, it is in-probable that a humanoid robot would be better at resolving the shortage when regarding ADL care than the combination of a human and technology would.

Since, at this time, SSRs would score too low on the requirements: environment-robot interaction, safety requirement, and societal and ethical requirements, the conclusion must be made that SSRs do not meet the required threshold. Therefore, the decision what made to exclude them from the user and viability analysis. (see chapter 8 for the mentioned requirements).

7.2 Housekeeping tasks

Especially in the elderly, handicapped, and psychiatric care housekeeping tasks were found to contribute to the workload and work intensity. Not only did they contribute to the workload, but healthcare workers noted that they would rather work with patients than do these housekeeping tasks. The following tasks and subsequent sub-tasks were identified:

1. HK1 Doing laundry:
   (a) HK1.1 Gathering laundry in laundry basket;
   (b) HK1.2 Taking laundry basket to the washing machine;
   (c) HK1.3 Putting the laundry from the basket into the washing machine. Recognizing the type of laundry and using the washing machine in the appropriate way;
   (d) HK1.4 Taking the laundry out of the washing machine, recognizing the laundry, and performing the appropriate follow-up steps;
   (e) HK1.5 Using the dryer machine;
   (f) HK1.6 Hanging the laundry up;
2. HK2 Tidying up the kitchen/living room space:
   (a) HK2.1 Gathering kitchen appliances from the living or dining space;

(b) HK2.2 Filling up the dishwasher, recognizing objects and the proper way of putting them into the dishwasher;
(c) HK2.3 Unloading the dish-washer and sorting the kitchen utensils;

3. HK3 General cleaning tasks:
   (a) HK3.1 Vacuuming (using a vacuum);
   (b) HK3.2 Sweeping the floor (using a broom);
   (c) HK3.3 Mopping floors (using a mop);
   (d) HK3.4 Polishing surfaces (using a cloth);
   (e) HK3.5 Disinfecting surfaces (using a spray-can);

7.3 Reporting and Administrative tasks

The reporting and administrative tasks scored high all across the board in the healthcare system. Although an SSR cannot partake in the consultations. Its microphone and sound system make the integration into a speech-based system more realistic. Connecting it on a broader scale with other smart devices, its communication capabilities could be used to log reports or relay messages. Making the reporting and administrative tasks more efficient. The following tasks and subsequent sub-tasks were identified:

1. RA1 Recording reports;
   (a) RA1.1 Recognize distinctive 'listen' phrase by healthcare worker;
   (b) RA1.2 Recognize healthcare environment (patient room, type of patient);
   (c) RA1.3 Text-to-speech the message;
   (d) RA1.4 Saving the report to the proper patient file in the cloud;
2. RA2 Relaying messages;
   (a) RA2.1 Recognizing distinctive 'Relay' phrase by healthcare worker and understand what file to 'Relay';
   (b) RA2.2 Text-to-speech the message;
   (c) RA2.3 Relay the information that was asked for;

The implementation of these tasks could be that a number of daily goals such as medication intake or observations such as abnormalities found during ADL tasks are recorded using the SSR. During this passive listening state (waiting for the 'listen' phrase) the SSR could be busy doing other tasks in the medical facility, adding to the overall efficiency and combining the user goals for the SSR.

It also does not have to be the actual microphones in the robot that record or relay the messages, but the robot could be used in unity with these microphones to be a part of a larger information system, relaying information recorded by other microphones when instructed to do so.

7.4 Daily Structuring tasks

Especially in handicapped and elderly care, this plays a large role. As the autonomy of clients grows more required and prevalent, it is increasingly important to keep activating people. Tasks regarding this span between entertainment and activation. The following tasks and subsequent sub-tasks were identified:

1. DS1 Converse with the client;
    (a) DS1.1 Listening to client and responding accordingly;
    (b) DS1.2 Ask questions accordingly;
    (c) DS1.3 Internally relay information that could be malignant to the client(s)
2. DS2 Entertain the client(s);
    (a) DS2.1 Sing to the client: Play an audio file that could be considered as vocalized music;
    (b) DS2.2 Dance for the client: Perform a move-set that could be considered dancing;
3. DS3 Morning motivation;
    (a) DS3.1 Waking the patient at the appropriate time;
    (b) DS3.2 Open the door to the bedroom, say 'goodmorning' 'how did you sleep';
    (c) DS3.3 Relay the schedule of that day to the client, relaying information gathered from the clients file;
    (d) DS3.4 Open the curtains;
4. DS4 Midday motivation;
    (a) DS4.1 Remind the client to eat or drink at certain time intervals;
    (b) DS4.2 Remind the client to take their medicine at certain time intervals;
5. DS5 Evening/night motivation;
    (a) DS5.1 Remind client to brush teeth;
    (b) DS5.2 Wish client good night;
    (c) DS5.3 During night: Analyze sleep pattern. Relay bad sleep behaviour to file;
    (d) DS5.4 In case insomnia, hum a tune to client and tell client to go back to sleep;

7.5 Peak Intensity tasks

A number of tasks were identified as being peak intensity moments. These tasks primarily add to the work intensity at certain moments in the day. These include the ADL tasks in the morning and evening, the distribution of medicine, eating moments, and the constant logistic needs during the everyday tasks. Since nurses remain the gold standard, it is not realistic that robots will do ADL tasks. However, it can provide an opportunity for the gold standard to perform more efficiently by helping during the peak intensity moments. The following tasks and subsequent sub-tasks were identified:

1. PI1 Making the tables/clearing the tables;
    (a) PI1.1 Placing the food on the trays;
    (b) PI1.2 Picking up the trays and moving toward the dining room;
    (c) PI1.3 Recognizing the lay-out and recognizing where clients are sitting;
    (d) PI1.4 Move toward clients and place the trays on the required tables;
    (e) PI1.5 Collect the trays after dinner;
    (f) PI1.6 Move trays back to kitchen;
2. PI2 Feeding the client;
    (a) PI2.1 Identify clients that cannot eat by themselves;

(b) PI2.2 Position in correct way to initiate 'feeding';
(c) PI2.3 Use the utensil to correctly feed the immobilized client;
(d) PI2.4 Continue to feed the client until client has had enough;

3. PI3 Dispersing medicine among clients;
   (a) PI3.1 Access makes use of the medicine cart used in medical institutions;
   (b) PI3.2 Move through the route identifying the different rooms where medicine should be dispersed to;
   (c) PI3.3 Give the right medicine to the right clients;
   (d) PI3.4 Make clients take the medicine. Whether they want to or not;
4. PI4 Logistics in hospitals;
   (a) PI4.1 Understand given tasks by healthcare workers such as 'get medicine A' or 'get a tray with medical supplies B';
   (b) PI4.2 Have an internal map of said institution and can move from location A to location B;
   (c) PI4.3 Identify wanted object and move said object from location B to A;

8 Viability analysis and Design Improvements

Now that the tasks have been identified, the viability of implementation should be tested. This will be done using a number of requirements, that is based on the literature review and the analysis, the limitations and capabilities of the social service robot EVE-r3 and the previously identified tasks. From this viability analysis, a number of design improvements will be suggested per individual core task.

8.1 SSRs implementation requirements

In order to be effective in healthcare, a number of requirements have to be met by the SSR. These requirements are structured into 4 different subsections: Environment-robot interaction, physical requirements, risk analysis, and societal and ethical limitations. These requirements are based on the literature review in section 33.

The environment-robot requirements set the standard for the way the robot should function in a healthcare environment. This is primarily task environment specific and also focuses on the viability of implementation. This entails but is not limited to: How should the robot respond to clients and workers, how should the clients and workers respond to the robot, and what manner of expertise is warranted from the worker in order to operate the robot.

Environment-Robot interaction requirements:

- ER1: Assertiveness warranted;
- ER2: Appearance warranted;
- ER3: Autonomy of the SSR warranted;
- ER4: Task complexity level (Intelligence);
- ER5: User-operation difficulty;

The mechanical requirements go into the minimal required physical capabilities the robot should have in

order to make a tentative difference in the healthcare environment. This is primarily focused on what the robot can do. This entails but is not limited to: What movements can it make, is the size compatible with the task, and can it produce the required force in order to do the tasks. Mechanical requirements:

- M1: Degrees of freedom;
- M2: Load limits for the effectors;
- M3: End effector grips;
- M3: Task complexity (Movements);

The risk analysis will aim to determine the risk that occurs when the SSR is used. These requirements entail but are not limited to: The chance of malfunction occurrences during certain tasks, the severity of the resulting malfunction, and the chance the malfunction gets detected before the situation worsens. Safety requirements:

- S1: Occurrence of malfunction;
- S2: Severity of malfunction;
- S3: Detection of malfunction;

The societal and ethical limitations aim to measure the viability that a humanoid robot could do these tasks by today's societal standards. These requirements entail but are not limited to: To what degree does it change current standards, how does it attain that change, and how does it play a role in resolving the worker shortage. Societal and ethical limitations:

- SE1: Dehumanization of the client;
- SE2: Gain of autonomy for the client;
- SE3: unburdening effect of healthcare workers;

8.2 Tasks vs requirements

Using thought experiments and facilitating questions that are shown in appendix 710.4.3, a validation analysis was done. All sub-tasks as shown in the user analysis were compared to the requirements, which led to the results in appendix 5.

The viability of the tasks compared to the requirements was measured on a scale from 1 to 5, where a value of 5 was given when it was estimated that EVE would be capable of the task without any design changes. A score of 3 or 4 was given when (slight) changes were necessary to qualify for the task. A score of 1 or 2 was only given when EVE is considered incapable of performing said task. A performed score was considered sufficient when the threshold of (n*5)-(n-1) was met, where n denotes the total number of requirements per type. In this case, the threshold is missed when all requirements of that type score slightly too low and lower. The score is orange when all (n*5)-(n The scores per task are shown in table 7.

This led to a number of observations. Namely that EVE is currently extremely capable regarding the mechanical aspects. Especially the housekeeping well, and the task regarding the service of food. Being of service in regards to the daily structuring tasks also looks promising. Furthermore, with some design changes, she could be implemented to partake in tasks such as reporting and administration, in case the right implementation criteria are met. Daily structuring and the guidance of clients in those regards also promising. Finally, EVE is most likely not applicable for tasks such as feeding patients. This was not unlike expected, since other ADL tasks were left out of this analysis due to that case.

Table 7: Validation analysis results summarised

	ER1	ER2	ER3	ER3	ER5	Tot:	M1	M2	M3	M4	Tot:	S1	S2	S3	Tot:	SE1	SE2	SE3	Tot:
HK1	5	5	4	3	5	22	5	5	5	5	19	3	4	5	12	5	5	5	15
HK2	5	5	5	3	5	23	5	5	5	5	20	3	4	5	12	5	5	5	15
HK3	5	5	4	5	5	24	5	4	5	5	19	4	4	5	13	5	5	5	15
RA1	5	4	5	4	5	22	5	5	5	5	20	4	3	5	11	5	5	5	15
RA2	4	4	5	5	5	23	5	5	5	5	20	4	3	4	12	4	5	5	14
DS1	2	4	5	2	5	18	5	5	5	5	20	3	5	5	13	4	5	5	14
DS2	4	3	4	5	5	20	5	5	5	5	20	5	5	5	15	4	5	5	14
DS3	4	3	4	5	5	20	5	5	5	5	20	5	5	5	15	4	5	5	14
DS4	4	3	5	5	4	21	5	5	5	5	20	5	5	4	14	5	5	5	15
DS5	4	3	5	4	4	21	5	5	5	5	20	5	5	4	14	3	5	4	13
PI1	5	5	5	5	5	25	5	5	5	5	20	5	4	5	14	5	5	5	15
PI2	3	2	3	4	5	17	5	5	5	5	19	5	2	5	12	2	4	5	11
PI3	3	2	4	5	4	17	5	5	5	4	19	5	2	4	11	4	5	5	14
PI4	5	5	3	4	4	21	5	5	5	4	19	5	3	5	13	5	5	5	15

8.3 Design requirements

In the viability analysis, EVE-r3 has been used to test the extent to which the tasks that have been identified can be resolved using an SSR. This lead to a clear indication of what can be regarded as realistic to implement right now, and which aspects should be improved upon. Using the different task subsets, the design improvements necessary to get the required scores for implementation will now be discussed.

8.3.1 Housekeeping tasks

EVE-r3 is very viable for implementation in housekeeping tasks. One limitation found was the complexity of certain tasks, that warrant a high level of situational awareness. One example of this is, picking up laundry: To what extent can the robot be taught to distinguish filthy laundry from clean laundry. Also, the usage of the washing machine could pose difficult to implement.

Ideally, the washing, dryer, and EVE are linked up to the same neural network and therefore the washing machine will use the same information that EVE gathers, making susceptibility to error significantly lower. This does require a high level of implementation cost, which could cost more than it will initially yield. Another important drawback is the skills that are expected of the healthcare worker to use this system. Ideally, it would run completely autonomously, but this might result in a longer development time. When the system is too hard to use, a healthcare worker might not have any interest in using the system.

From a mechanical standpoint, EVE would be very capable of handling these tasks. One of the drawbacks might be the torque that the hands are exposed to during mopping or vacuuming. However, since the hands can be easily replaced, several different hands might be implemented for different tasks. When regarding the safety requirements: Since these housekeeping tasks do not occur in direct contact with humans these are relatively low. The only drawback here is that if the robot runs completely autonomous, the detection of malfunction might get slightly too high.

The societal and ethical requirements also score well in these regards. An important factor in this is the fact that when these tasks are automatized, healthcare workers have more time for clients, actually making it ethically beneficial.

8.3.2 Reporting and administrative tasks

This is where EVE can gain a lot of ground. The reason for this is simple: EVE is not yet designed to do this. It does not have to be the main focus, but this is something that should be considered. Building an integrated neural network that uses the microphones and speakers native to EVE to distribute information more efficiently and effectively could greatly reduce the workload of administrative tasks. Even though EVE could be part of this system, it should not be the main focus of her design.

The usability of EVE in this regard will greatly benefit deep-learning and language technology. Even though EVE would be successful at certain tasks, language technology has to further progress to fully benefit from its capabilities.

8.3.3 Daily-structuring tasks

Like other social robots that are being used in healthcare right now, it seems that EVE could be beneficial in offering daily structure to clients. There is however one major drawback in this instance, and that is the way EVE looks. Being a robot that is almost two meters high, it might be too intimidating to some clients, in order to effectively activate them. The way to solve this is by making the design of the robot more endearing, and therefore less intimidating. At the same time, making the robot smaller would make it less applicable for housekeeping tasks.

Another important issue is the societal and ethical circumstances. With healthcare becoming more at-home-based, the primary contact for clients being a robot could pose ethical restraints. Not only in at-home-based healthcare but the idea that clients could be woken up by a LED screen instead of a human face could be a liable societal development.

EVE does seem to be viable for morning routines and entertainment for the clients. Even though the results in chapter 5 showed that clients react positively to robots, a more detailed analysis of how they would react to EVE is still required. All in all, social robots can play a big role in terms of entertaining and activating clients, but if EVE currently is the best option for this should be investigated.

8.3.4 Peak-intensity moments

In this regard EVE also scores very high. If implemented correctly, EVE could make a big difference in regards to the distribution of food or solving logistic problems in all sectors of healthcare. The two lowest-scoring factors here were medicine distribution and the feeding of patients. The severity of malfunction in medicine distribution can not be ignored. This task can simply not be done fully autonomously to negate this risk. Also, the method of medicine implication in hospitals goes through a tube directly into the body, which makes the task rather complex to be handled by an SSR in the near future. Much like the reservations in regards to the ADL tasks, feeding patients also do not score high enough. Even though the (lack of) complexity of the task makes it viable for implementation, its severity of malfunction and the dehumanizing factor might not make this realistic to implement.

8.4 General design advice

In conclusion, the main tasks that should be focused on are in regards to housekeeping and peak intensity tasks. Normalizing the presence of service robots in our society will take away the reservations people have

about them, and in time they could be allowed to do more than only the more basic tasks. Allowing EVE to use diverse end effectors could make it very viable for a wide range of housekeeping tasks.

Another important thing to keep in mind during the design of tasks for EVE is the availability of other healthcare technology. If other methods are more efficient and better at doing tasks than a service robot would be, these tasks should not be diverted to EVE.

This also amounts to the fact that healthcare workers will remain to be the gold standard in terms of ADL care. However, limiting the amount of time that they have to invest into the secondary tasks will allow them to focus more on ADL care, increasing the overall healthcare quality.

Finally, in order to make social service robots as effective as possible, they should be implemented complementary to other technical innovations. For instance, using big data and smart sensors, social service robots can be used as the 'friendly' face in between. This would resolve the heavy workload of the administrative work and it could help with relaying information to clients where healthcare workers might not be able to do that.

9 Conclusion

The goal of this thesis was to conduct a user analysis of medical institutions in order to lower the current workload and to advise on some design improvements in order to make EVE-r3 more applicable. This was done through the resolving of three research questions. These goals have been met in chapters 7 and 8, which means this thesis has met its conclusion.

10 Discussion

Now that this thesis has been concluded, a number of aspects of this thesis will be discussed and future studies will be suggested.

10.1 Conflict of interest

When regarding the conclusions of this thesis, some level of nuance is required. As has been stated in the introduction, this thesis was done as a graduation assignment for NAKAMI ROBOTICS, which means there was a tendency to find that the robot would be applicable in healthcare. Normally when one aims to solve a complex problem the first step would be to analyse the problem in order to fully understand it. After this problem analysis has been completed, technical innovations that could solve it can be investigated and linked to the problem.

In this thesis, this was actually done the other way around. Instead, a solution was given and the aim was to find the way this solution could be applied to the overarching problem. This constitutes a number of problems. First of all, the healthcare system proved to be more complex and intricate to truly dissect in a ten-week thesis. This means that the conclusions, that were generalized for the entirety of the institution, probably do not fully encapsulate the problem. To a certain degree, this takes away from the reliability of the conclusions drawn in this thesis, but this also opens up doors to new investigations.

10.1.1 User analysis vs Descriptive study

The instigation of this thesis was a user analysis for the robot EVE-r3 in relation to healthcare. This soon proved to be an assignment that could not be done via the standard user-analysis code of conduct, since the assessment of these institutions proved too vast. For this reason, there was chosen for a descriptive studylike method, which used a multi-method approach to the problem. A descriptive study is often used when one tries to identify means to improve upon an existing institution. And as the main goal of the implementation of EVE-r3 within healthcare is to do that, this decision was considered the correct one. However, this also meant it took more time to actualize the answers to the instigation of this investigation.

10.2 Research population

Another important point of discussion is the selection of the research population. It turned out to be very time-consuming to realize a research population that was a true sample of the Dutch healthcare system. In order to realize a population group, the focus was primarily placed on a partnership with the Landstede groep. Even though this partnership turned out to be very successful, this did not yield a true sample of the entire healthcare system. This led to the fact that in contrast to the handicapped and elderly care, the general hospital did not bear as much fruit as for the other healthcare branches.

10.3 Complementary research

These points of discussion all hinge on one important understanding: this thesis was an exploratory review. Only identifying some tasks in the broad sea of the healthcare system. Diving deeper into the diversity of this institution could yield more profound ideas that were not discovered in this analysis. This review opens the door to a number of complementary investigations.

10.3.1 At home care

At-home care will continue to grow in the coming decades. The application of service robots on a smaller scale could prove very help full for this growing sector. This would not unburden the healthcare sector, however, since the primary workload for healthcare workers will be ADL and not the housekeeping tasks or the daily structuring tasks in at-home care, but it will allow the elderly to live a more autonomous and worthy life.

10.3.2 General hospital care

As has been stated before, this research can be expanded in regard to general hospital care. This part of healthcare is very broad and complex, and this thesis did not fully penetrate this problem. This review identified that the workload in general hospitals could be made more efficient by improving logistical tasks. This could however be expanded upon.

10.3.3 Compared to other social robots

The viability analysis in this study was only based on EVE-r3. Redoing this viability analysis with other SSRs could yield a more universally applicable solution to the shortage.

10.3.4 Implementation analysis

The Dutch healthcare system has an implementation problem. If EVE is going to be implemented in the healthcare system, an implementation plan should be constructed to how this will be made possible. One major step in this could be to run pilots in hospitals using EVE mainly as a service robot, further expanding the acceptance of EVE over time. Analyzing how these pilots progress and how clients and workers alike respond to this new technology will allow the implementation to go smoother.

10.4 Research strategy

For this study, a multi-method descriptive review was chosen. This encompassed a literature study, a quantitative review, and a qualitative review. Also, in order to do these reviews, a social network had to be constructed first. In the end, this leads to a broad analysis. Reflecting on the research strategy, a number of things should be noted.

10.4.1 Survey

The survey was not as extensive as would have been ideal. This was partly done in order to have the survey not take longer than 10 minutes to answer and to make sure that a proper sample was collected. The drawback to this is that each variable is only tested by one or two questions. This did not allow for statistical tests that determine the reliability of the survey, which means that there is no way to know for certain that the results of the closed questions are reliable.

10.4.2 Interview

Having given input from four major healthcare branches the qualitative review resulted in results that offered the broadness that was hoped for. However, in future research, multiple people from each branch should be interviewed to be able to compare the results. Since the current results can only be used for an exploratory analysis, where for the implementation a more substantial analysis is necessary.

10.4.3 User and viability analysis

The highly subjective nature of this analysis should be substantiated with a more in-depth exploration of future inquiries. The requirements were mostly chosen on intuition, which was sufficient for this thesis, however before the implementation phase comes these requirements should be further expanded upon.

Appendix 1: Survey structure

Kernbegrip	Dimensie	Topics	Bijbehorende vragen
Schaarste in de zorg	1.1 Doelgroep	1.11 Functie binnen de zorg	S1.111 – Wat is uw functie binnen de zorg?
		1.12 Zorg doelgroep	
			S1.121 – Met welke doelgroep in de zorg werkt u?
		1.13 Ervaring in de zorg	S1.131 – Hoe lang bent u al werkzaam in de zorg in het algemeen?
			S1.132 – Hoe lang bent u al werkzaam in deze tak van zorg?
		1.14 Tevredenheid met het werk	S1.141 Ik geniet van mijn werk (1-10)
			S1.142 Ik vind dat ik nuttig werk doe (1-10)
	1.2 Werkdruk	1.21 Werkdruk/tijdsdruk	S1.211 – ik ervaar tijdsdruk bij mijn werk (1-10)
			S1.212 – Kunt u toelichten welke taken
			tijdsdruk opleveren?
			S1.213 - dagelijkst zit er variatie tussen intensieve en rustige taken op een dag (1-10)
		1.22 Huishoudelijke taken	S1.221 - Huishoudelijke taken zijn een deel van mijn basistaken op een dag (1-10)
			S1.222 – Huishoudelijke taken welke ik vaak op een dag moet uitvoeren zijn:
			S1.223 – Ik ben relatief veel met opruimen en met schoonmaken van de zorginstelling bezig (1-10)
			S1.224 – welke bezigheden behouden dit? (aansluitend op S1.223)
		1.23 Rapporteren en overleggen	S1.231 – Ik heb gedurende de werkdag relatief veel professioneel overleg met mij collega's (1-10)
	1.3 Werkintensiteit	1.31 Werkintensiteit/fysiek intens	1.311 Ik ervaar mijn werk als intensief (1-10)
			1.312 Na mijn werkdag ervaar ik fysieke vermoeidheid/hinder door mijn werk als zorgmederwerker (1-10)
			1.313 – Het soort taken waardoor ik lichamelijke ongemak ervaar omvatten:

			1.314 - Dagelijkst zit er variatie tussen intensieve en rustige taken op een dag (1-10)
			1.315 – Ik besteed X procent aan taken die ik als intensief zou beschrijven per dag (0 - 100)
		1.32 ADL zorg	1.321 – Ik besteed tijd aan het bieden van ADL zorg aan patiënten welke zij zelf niet (meer) kunnen uitvoeren (1-10)
			1.322 – Indien u veel bezig bent met ADL zorg, welke taken vergen de meeste tijd?
		1.33 Verstrekken medicijnen	S1.331 – ik besteed tijd aan het verstrekken van medicatie (1-10)
BV			BV1 – Ruimte voor aanvullende opmerkingen:

Appendix 2: Survey results

Code	Vragen en antwoorden:
S1.212	Kunt u toelichten welke taken tijdsdruk opleveren?
	Algemeen ziekenhuis: N = 10 Zorgzwaarte – onderzoeken en artsenvisite – nauwkeurigheid handelingen – multitasksen – administratie – consulten – spoedgevallen – administratie – schoonmaken – administratie – eten delen – medicatie verstrekken – bedden verschonen – ADL verzorging - administratie
	Geestelijke gezondheidszorg: N = 4 Uitzendkrachten – schoonmaakwerkzaamheden – te weinig personeel
	Gehandicaptenzorg N = 29 Administratie – huishoudelijke taken – huishoudelijke taken – rapporteren – overleg – arbeidsmarkt en zorg – overleg en contact – rapporteren – inlezen – (Ochtend) ADL – rapportages – administratie – administratie – rapporteren – begeleiding – facilitaire zaken – huishoudelijke taken – rapportages – niet goed ontwikkelde IT-infrastructuur – administratie – administratie – administratie
	VVT Thuiszorg N = 14 Administratie – (structuur thuiszorg) per minuut ingepland per cliënt wat tijdsdruk oplevert – te weinig tijd voor gesprek met client – onvoorziene dingen – ADL – krappe indicatie – reistijd – zomerperiode
	VVT verpleeghuis/ verzorgingstehuis N = 23 Rapporteren – huishoudelijke taken – (woon) kamer schoon houden – rapporteren – medicatie – huishoudelijke taken – ADL (ochtend en avond) – rapporteren – medicatie bestellen (neven taken) – zorgtaken – dagstructuur – ADL (‘s ochtends) – therapie – consulten – ADL
	Others N = 2 Te veel administratief werk – administratie - huishoudelijk werk
S1.313	Het soort taken waardoor ik lichamelijke ongemak ervaar omvatten:
	Algemeen ziekenhuis: N = 10

	Hoge zorgzwaarte ADL – artsenvisite – rapporteren – zware patienten ADL - veel lopen – staan/traplopen/bukken – lopen afstanden – patiënten vertillen (klinisch onderzoek) – ADL – Klinische onderzoek
	Geestelijke gezondheidszorg: N = 4 Huishoudelijke taken – aggressieve bewoners – (geestelijke) vermoeidheid door patiënten
	Gehandicaptenzorg N = 29 Zwaar tilwerk – agressie – bukken, tillen, lopen – verschoning – zwaar tillen, veel lopen – lopen – agressie – wasmanden, afvalcontainer – lopen – douchen – huishoudelijke taken – patienten in/uit bed vertillen – veel clienten – ADL – huishoudelijke werkzaamheden – tillen – ongeschikte werkruimte – ontsnapte clienten – tillen – lopen – ADL – ADL - ADL
	VVT Thuiszorg N = 14 ADL – ADL – bukken – reizen – client verschonen - douchen
	VVT verpleeghuis/ verzorgingstehuis N = 23 ADL – ADL – ADL – ADL – ADL – ADL – ADL – ADL – ADL – geen pauzes – ADL – ADL – lopen – ADL – ADL – tillen van objecten – ADL - ADL – ADL (zorgzwaarte groeit) – ADL
	Others: N = 2 Huishoudelijke taken - ADL
S1.322	Indien u veel bezig bent met ADL zorg, welke taken vergen de meeste tijd?
	Algemeen ziekenhuis: N = 10 ADL hoge zorgzwaarte (post ic) – wassen + verpleegtechnische handelingen – wonden verzorgen – wassen op bed – wassen – bed verschonen – eten geven
	Geestelijke gezondheidszorg: N = 4 Douchen of wassen – aan/uitkleden – toiletbezoeken – douchen
	Gehandicapten zorg Verschonen – omkleden – wassen – douchen – aankleden – verschonen - eten geven – tandenp poetsen – haren kammen – kleden – douchen – avond/ochtendroutines – douchen – wassen aankleden – douchen – naar toilet gaan – naar bed brengen
	VVT Thuiszorg N = 14 Kleden – geduld hebben – douchen – toiletgang – kleden – douchen – kleden – douchen – kleden – douchen – kleden – steunkousen aandoen – douchen – kleden – douchen – uiterlijke verzorging – douchen - kleden
	VVT verpleeghuis/ verzorgingstehuis N = 23 Transfers (van bed naar rolstoel) – eten en drinken – wassen - kleden – steunkousen – mobiliseren – toiletgang – douchen – douchen – douchen – ADL hoge zorgzwaarte – kleden – kleden – wassen – kleden – rolstoelgangers – ADL – toiletgang – douchen – douchen – ADL – rapporteren – huishoudelijke taken – wassen – kleden – dagelijkse begeleiding – douchen – (passieve) transfers – wassen – kleden – ADL – transfers – ADL – (hoge zorgzwaarte) ADL
S1.332	Huishoudelijke taken welke ik vaak op een dag moet uitvoeren zijn:
	Algemeen ziekenhuis: N = 10 Afdeling globaal opruimen – ontsmetten – bedden verschonen – bedden verschonen
	Geestelijke gezondheidszorg: N = 4 Schoonmaken – bed verschonen – vegen – dweilen – de was doen – vaatwasser – tafels dekken – stofzuigen – dweilen – afstoffen – bedden verschonen – toiletten – badkamers – kantoor – washok – koken – boodschappen doen
	Gehandicapten zorg Schoonmaken – was – eten – koken – etensresten – opdweilen – wasjes doen – stofzuigen – stofzuigen – vaatwasser – eten – vaatwasser – de was doen – schoonmaken – was – kamers - huiskamer – koken – wasen – vegen – vaatwasser –

	bedden opmaken – badkamers schoonmaken – wassen – poetsen – koken – boodschappen – koken – wassen – schoonmaken – bedden verschonen – wassen – poetsen – koken – boodschappen – koken – afwas – stofzuigen – bedden verschonen – was – afwas – koken – schoonmaken – boodschappen
	VVT Thuiszorg N = 14 Gunsten – minimaal in de thuiszorg – afwassen – over het algemeen NVT
	VVT verpleeghuis/ verzorgingstehuis N = 23 Handdoeken verversen – bedden opmaken – prullenbak ledigen – vaat doen – eten en drinken – afwassen – bedden verschonen – toilet – schoonmaken – etten – was – vuilnis – was – bedden opmaken – toilet – vuilnisbakken – bedden opmaken – keuken schoonhouden – toiletten en wastafels – bewoners schoonmaken – eten – opruimen – was – wassen – tafellakens – wc schoonmaken – dweilen – was opruimen – boodschappen opruimen – koken – badkamers schoonmaken
S1.334	welke bezigheden behouden dit? (aansluitend op S1.223)
	Algemeen ziekenhuis: N = 10 Kamers schoon en opgeruimd – opruimen – ontsmetten – ontsmetten – opruimen – opruimen
	Geestelijke gezondheidszorg: N = 4 Was – vuilnis
	Gehandicaptenzorg Stofzuigen – schoonmaken keuken – opruimen kasten - verschonen bedden – opruimen – stofzuigen -opruimen – was – algemene hygiëne – was – facilitaire zaken – keuken – badkamer – vaatmachine – afruimen – schoonmaken – bedden verschonen – was – bedden verschonen – stofzuigen – dweilen – opruimen – was – afwas – opruimen
	VVT Thuiszorg N = 14 Badkamervloer – opbergen - NVT over het algemeen
	VVT verpleeghuis/ verzorgingstehuis N = 23 Vaat – was – dweilen – vegen – afwas – schoonmaken – dweilen – vegen – bedden opmaken – stofzuigen – vloer vegen – dweilen – schoonmaken – was – dweilen – afval – schoonmaken toilet douche – medicatie – uitruimen spullen – was draaien – as – dweilen – afval – kamer bewoners opruimen – schoonhouden wc – rolstoelen opruimen/schoonmaken – prullenbakken verversen – verzorgingsmateriaal opruimen – dekken van de tafel
BV1	Ruimte voor aanvullende opmerkingen:
	Algemeen ziekenhuis: N = 10 Mentale vermoeidheid – mentale vermoeidheid
	Geestelijke gezondheidszorg: N = 4 Opkomst van techniek maakt de zorg draagbaarder – medicatie kost veel tijd – verpleegtechnische handelingen dienen secuur gedaan te worden
	Gehandicaptenzorg Frustratie door werkdruk – cliëntzorg is intensief – prioriteit bij patiënten wat administratief werk geestelijk vermoeiend maakt
	VVT Thuiszorg N = 14 Intern overleg belangrijk
	VVT verpleeghuis/ verzorgingstehuis N = 23 Weinig tijd voor overleg – weinig tijd voor overleg – weinig overleg mogelijkheid door alleen werken – overweeg te stoppen met zorgsector door hoge werkdruk

Appendix 3: Interview structure

Kernbegrip	Dimensie	Topics	Bijbehorende vragen
Schaarste in de zorg	1.1 Zorgtak	1.11 Functie binnen de zorg	V1.111 – Zou u eens wat meer willen vertellen over uw functie?
		1.12 Zorg doelgroep	V1.121 – Met welke doelgroep in de zorg houdt u zich vooral bezig
			V1.122 – Wat zijn de uitdagingen bij deze doelgroep?
			V1.123 – Wat voor soort verzoeken tot vragen krijgt u vooral bij deze doelgroep?
		1.13 Tevredenheid met het werk	V1.131 – Wat zijn de uitdagingen bij deze doelgroep? Wat maakt dit werk intensief of druk?
	1.2 Werkdruk	1.21 Huishoudelijke taken	V1.211 – Waar ligt de werkdruk mbt huishoudelijke taken?
		1.22 ADL zorg - aankleden	V1.221 – Waar ligt de werkdruk mbt ADL taken?
		1.23 Verstrekken medicijnen	V1.231 – Waar ligt de werkdruk mbt verstrekken van medicijnen?
		1.24 Verslag leggen en interne communicatie	V1.241 – Waar ligt de werkdruk mbt verslag leggen en interne communicatie?
		1.25 Werkdruk	V1.251 - Wat zijn de uitdagingen bij deze doelgroep? Wat maakt dit werk intensief of druk?
	1.3 Werk intensiteit	1.31 Dagstructuur	V1.311 – Waar ligt de werkintensiteit hoog bij het bieden van dagstructuur? En kan zorgtechnologie hier iets bij betekenen?
		1.32 ADL zorg – wassen en klinisch observeren	V1.321 – Waar ligt de werkintensiteit hoog bij ADL taken zoals het wassen of klinisch observeren?
		1.33 Eten verstrekken aan de cliënten	V1.331 – Waar ligt de werkintensiteit hoog bij het verstrekken van eten?
		1.34 Fysieke belasting	V1.341 - Wat zijn de uitdagingen bij deze doelgroep? Wat maakt dit werk intensief of druk?
Invloed technologie op de zorg	2.1 Zorg innovaties 2.2 Humanoid Robots	2.11 Welk soort zorg innovaties ontwikkelen op dit moment	V2.111 – Wat voor verzoeken tot innovatie krijgt u vooral in deze doelgroep? Waar ziet u mogelijkheden voor meer toepassing van zorgtechniek binnen uw instelling? V2.112 – Welke (nieuwe) zorginnovaties gebruikt u nu veel bij uw instelling?
		2.12 Toekomst beeld van technologie in de zorg (verwachtingen met betrekking tot schaarste).	V2.121 – Waar ziet u zelf het meest winst voor zorgtechnologieën voor uw doelgroep?
			V2.122 - Waar ligt de werkdruk hoog bij huishoudelijke taken? En kan zorgtechnologie hier iets bij betekenen?
			V2.123 - Waar ligt de werkdruk hoog bij ADL taken? En kan zorgtechnologie hier iets bij betekenen?

			V2.124 - Waar ligt de werkdruk hoog bij het verstrekken van medicijnen? En kan zorgtechnologie hier iets bij betekenen?
			V2.125 - Waar ligt de werkintensiteit hoog bij het bieden van dagstructuur? En kan zorgtechnologie hier iets bij betekenen?
			V2.126 - Waar ligt de werkdruk hoog bij ADL taken zoals het wassen of klinisch observeren? En kan zorgtechnologie hier iets bij betekenen?
			V2.127 - Waar ligt de werkdruk hoog bij het verstrekken van eten? En kan zorgtechnologie hier iets bij betekenen?
			V2.128 – Hoe ziet u de toekomst van zorgtechnologie binnen uw organisatie?
			V2.129 – Denkt u dat zorgtechnologie de primaire oplossing is tegen het zorgmedewerkers tekort?
		2.21 Ervaringen met humane zorgrobots	V2.211 – Heeft uw organisatie al eens met zorgrobots gewerkt? Wat was hier uw ervaring mee? Hoe reageerde de medewerkers hier op? Hoe reageerde de cliënten hierop?
		2.22 Verwachtingen van humane zorgrobots	V2.221 – Hoe kan een menselijke zorgrobot iets betekenen bij het tegengaan van werkdruk en werkintensiteit?
			V2.222 – Naar uw mening, wat voor soort taken zou een menselijke zorgrobot over kunnen nemen?
		2.23 Reserveringen bij humane zorgrobots	V2.231 – Welke nadelen ziet u bij het gebruik van menselijke zorgrobots?
Bijvangst			BV1 – Heeft u nog aanvullingen op de voorgaande vragen? Bv2 –

Appendix 4: Interview results

Code	Position	Date (pm)	Length interview
Int1	Carer and innovation coordinator	10 June 2022	45.32
Int2	Nursing school teamleader	13 June 2022	39.01
Int3	Carer and innovation coordinator	21 June 2022	33.09
Int4	Carer and teacher	24 June 2022	21.03

Code	Vragen en antwoorden:
V1.111	Zou u eens wat meer willen vertellen over uw functie?
	Int1: Coördinator innovatie bij het woonzorgpark in Apeldoorn. Implementatie van innovaties in de breedste zin van het woord. Kijkend vanuit de vraag van de medewerker of de patiënt hier in Apeldoorn. Int2: Teamleider verpleegkunde opleiding. Verzorger en verzorgende ig. Interim bij studie gehandicapte zorg. Breed werkveld: Algemeen ziekenhuis, ouderenzorg, psychiatrie en thuiszorg. Int3: Ouderenzorg project manager. Op it gebied en innovatiecoach. Int4: De laatste 11 jaar werkzaam geweest als IC verpleegkundige binnen de Isala in Zwolle. Daarvoor 2 jaar op de chirurgische afdeling maag/darm en vaat. De afgelopen 1,5 jaar werk ik niet meer in de zorg.
V1.121	Met welke doelgroep in de zorg houdt u zich vooral bezig
	Int1: Voornamelijk gehandicaptenzorg. 450 cliënten wonen (directe gehandicaptenzorg) en in Apeldoorn zelf nog 250 clienten in begeleiding (thuiszorg). Int2: Huidige doelgroep mbo studenten niveau 3 en 4. Daarmee veel ervaring met alle doelgroepen binnen de zorg. Int3: Ouderenzorg. Regio Noord-west Veluwe. 25 locaties waar clienten wonen, daarnaast thuiszorg. Int4: Vooral dus met ernstig zieke patienten die vaak in slaap gehouden worden ivm hersenoperatie, ongeval, ernstige infecties, hartoperaties, longoperaties, covid patienten etc
V1.122	Wat zijn de uitdagingen bij deze doelgroep?
	Int1: 60-70% van de tijd (werkdruk) gaat naar administratieve werkzaamheden. Zorgmedewerkers vinden het lastig om te gaan met techniek. Moet niet ingewikkelder zijn dan het inprikken van een stekker. Int2: Gehandicapten zorg: Veel diversiteit. De ene groep vergt vooral veel dag-structuur, tot en met clienten welke op babyniveau functioneren en waar de hele ADL-zorg moet. Voedsel voorbereiding kost hier ook extra tijd. In de psychiatrie is het vergelijkbaar + onverwachtse gedragspatronen. Doel bij gehandicapten zorg is verbetering en het autonomer worden. Bij ouderenzorg is het meer het vasthouden van de autonomie. Hier gaat het ook meer om risico analyse. In het ziekenhuis veel klinisch redeneren. Vaak checken van de vitale functies. Int3: Medewerkers elke dag uur kwijt aan rapporteren. Dit omdat thuiszorg werkt met doelen welke afgetekend moeten worden. Grote verschillen tussen pg psychotherapie en somatiek. Veel wisseling in focus. ADL groeit stevig door toename minder zelfstandige zorgvragers. Int4: Lichamelijke verzorging en de registratie van gegevens
V1.123	Wat voor soort verzoeken of vragen krijgt u vooral bij deze doelgroep?
	Int1: Op dit moment met name stressdetectie. sensoren de spanningen op gaan lopen binnen een groep of bij een cliënt. Tot kleine dingen zoals een client die zich niet meer goed kan vermaken. Alles is met name patiënt of medewerker georiënteerd. Kleine

	robot James robot James welke rond rijdt met een chatprogramma, dit was met name in corona tijd van belang met betrekking tot. Int2: Niet van toepassing Int3: Implementatie van zorgtechnologie Int4: Niet van toepassing
V1.131	Wat zijn de uitdagingen bij deze doelgroep?
	Int1: 60-70% van de tijd (werkdruk) gaat naar administratieve werkzaamheden. Zorgmedewerkers vinden het lastig om te gaan met techniek. Moet niet ingewikkelder zijn dan het inprikken van een stekker. Combinatie van dag-structuur bieden en het doen van huishoudelijke taken. Intensief is bijvoorbeeld de eetmomenten. Int2: Geen antwoord Int3: Grotere groep niet zelfstandige. Deze groep groeit stevig, er wordt meer ingezet op thuiszorg. Dit balanceren is een uitdaging. Int4: Lichamelijke verzorging en de registratie van gegevens
V1.211	Waar ligt de werkdruk hoog bij huishoudelijke taken?
	Int1: Bijvoorbeeld de was doen en opvouwen of het uitserveren van eten. Int2: Piekmoment eten uitserveren Int3: Piekmomenten (zoals eten uitserveren) Int4: Niet van toepassing. Piekmomenten uitserveren eten, maar dit werd onder ADL geschaald
V1.221	Waar ligt de werkdruk hoog bij ADL taken?
	Int1: Werkdruk of werkintensiteit vooral gelieerd aan rolstoelgangers. Int2: Vooral volledigheid lastig om te handhaven. Beperkte communicatie middelen van cliënten is hier lastig. Daarnaast kent een ADL taak heel veel verschillende doelen Int3: Deze groep groeit sterk. Groep die op locatie komt wonen is er nu vaak een stuk erger aan toe. Int4: Zeker 4 uur per dag. Dit behelst wassen, verschonen, mensen op de stoel helpen/mobiliseren.
V1.231	Waar ligt de werkdruk hoog bij het verstrekken van medicijnen?
	Int1: Heel divers in deze sector. Dit maakt het wel foutgevoeliger. Int2: Onderdeel van een piekmoment. Int3: Vooral bij de thuiszorg voert dit de boventoon. Lastig om goed te reguleren en erg foutgevoelig. Int4: Ca. 1u per dag? Omdat dit vaak via de maagsonde en het infuus gaat neemt dit ook wel wat tijd in beslag.
V1.241	Waar ligt de werkdruk mbt verslag leggen en interne communicatie?
	Int1: 60-70% van de tijd (werkdruk) gaat naar administratieve werkzaamheden. Zorgmedewerkers vinden het lastig om te gaan met techniek. Moet niet ingewikkelder zijn dan het inprikken van een stekker. Combinatie van dag-structuur bieden en het doen van huishoudelijke taken. Intensief is bijvoorbeeld de eetmomenten. Int2: Geen antwoord. Int3: Ligt erg hoog. Komt omdat er vaak doelgericht wordt afgetekend. Medewerkers zijn vaak in hun eigen tijd nog een uur bezig met het invullen van allerlei rapporten. Deze taken groeien ook sterk. Int4: Afhankelijk van de stabiliteit van de patient ca. 2u. De vitale getallen worden wel geregistreerd door de computer echter moeten wel gevalideerd worden, evenals wisselingen in pompstanden en bijhouden van de orale intake en verliezen d.m.v. vocht uit drains en urineproductie uit de katheter. Ook het rapporteren is een belangrijk onderdeel, evenals het schrijven van rapportages en het lezen van de voorschriften van de arts en andere disciplines zoals dietiste, fysiotherapie etc
V1.251	Wat zijn de uitdagingen bij deze doelgroep? Wat maakt dit werk intensief of druk?

	Int1: Met name het rapporteren en dagstructuur Int2: In de psychiatrie vooral het onbegrijpbaar handelen. Mensen gedragen zich relatief vaak agressief (naar zichzelf) Int3: Groeiend in zwaarte met betrekking tot ADL, dagstructuur en daarmee het rapporteren. Int4: De lichamelijke verzorging en de registratie van gegevens. Met betrekking tot logistiek is heel erg wisselend per patient. Wanneer de patient wisselt van afdeling/ naar de operatiekamer gaat of onderzoeken krijgt kan dat soms wel 1 uur zijn.
V1.311	Waar ligt de werkintensiteit hoog bij het bieden van dag structuur?
	Int1: Hoge intensiteit ervaren bij dagstructuur. Met name het bieden van dagstructuur aan zoveel bewoners is lastig. Iedereen wordt op hetzelfde moment wakker en verwacht dan vergelijkbare dingen. Int2: De grote diversiteit tussen cliënten. Je wilt mensen autonomie bieden, dat is lastig te doen in massa productie. Int3: Zeker in de thuiszorg grote vraag naar. Zeker met betrekking tot alleenstaanden. Int4: Niet van toepassing
V1.321	Waar ligt de werkintensiteit hoog bij ADL taken zoals het wassen of klinisch observeren?
	Int1: Veel wilsonbekwame cliënten. Het mooie aan dit werk is dat je mensen helpt, het lastige is dat cliënten in deze sector niet altijd communiceren wat ze willen of bedoelen. Het vergt veel ervaring om daar behulpzaam in te zijn. Int2:. Mensen worden het liefst altijd ’s ochtends gedoucht en gekleed, dit maakt de ADL vaak fysiek zwaar. Int3: Deze taken groeien sterk in werkdruk, aangezien de cliënten die binnenkomen steeds minder zelfredzaam zijn. Int4: Grote factor, met name met betrekking tot zwaardere patienten
V1.331	Waar ligt de werkintensiteit hoog bij het verstrekken van eten?
	Int1: Met name dat patiënten dit op hetzelfde moment willen hebben. Int2: Een piekmoment. Veel op 1 moment. Diversiteit tussen patiënten maakt dit ook lastig. (Voorgemalen eten etc.) Int3: Een piekmoment. Int4: Een piekmoment
V1.341	Wat zijn de uitdagingen bij deze doelgroep? Wat maakt dit werk intensief of druk?
	Int1: Taken met hoge intensiteit zijn altijd gelieerd aan rolstoelgebruikers. Int2: In de psychiatrie vooral het onbegrijpbaar handelen. Mensen gedragen zich relatief vaak agressief (naar zichzelf)? Int3: Deze doelgroep wordt over het algemeen steeds intensiever. Cliënten die binnen komen vergen steeds intensievere zorg en vertonen minder verklaarbaar gedrag. De hoeveelheid agressie groeit sterk. Hierin begint de ouderenzorg meer te lijken op de psychiatrie. Int4: De lichamelijke verzorging en de registratie van gegevens. Met betrekking tot logistiek is heel erg wisselend per patient. Wanneer de patient wisselt van afdeling/ naar de operatiekamer gaat of onderzoeken krijgt kan dat soms wel 1 uur zijn. Maar patienten die dat niet hebben heb je dat minder mee. Patienten op de IC moeten best vaak wisselligging krijgen, dus ze moeten vaak gedraaid worden, dit kost vaak fysiek veel. Dit gebeurt ook bij het wassen en verschonen (draaien/verplaatsen van de patient in zijn eigen bed) Vaak zware patienten op de IC en het komt naast een glijzeil vaak aan op de verpleegkundigen. Ook het op een ander bed verplaatsen van de patient is fysiek zwaar.
V2.111	Wat voor vragen krijgt u vooral in deze doelgroep?/ Waar ziet u mogelijkheden voor meer toepassing van zorgtechniek binnen uw instelling?

	Int1: Op dit moment met name stressdetectie. Middels sensoren kijken wanneer de spanningen op gaan lopen binnen een groep of bij een cliënt. Alles is met name patiënt of medewerker georiënteerd. Kleine robot James robot James welke rond rijdt met een chatprogramma. Int2: Geen antwoord Int3: Standaard werk processen vereenvoudigen of versnellen. Spraakmemo's of robots die op kamers ter vermaak zijn (voorbeeld robot Sara). Slimme sensoren met valdetectie veel potentie, zo kan 1 zorgmedewerker op 50 tot 60 bewoners functioneren. Int4: Communicatie en vermindering van de fysieke belasting. In het ziekenhuis wordt nog weinig gebruik gemaakt van zorgtechnologie in mijn ogen. Hulpmiddelen voor steunkousen/ted kousen worden nog weinig toegepast. Nu vaak alleen nog nieuwe tilliften, camera's en detectie mogelijkheden (val, uit bed stap detectie etc.)
V2.112	Welke (nieuwe) zorginnovaties gebruikt u nu veel bij uw instelling?
	Int1: waar nu naar gekeken wordt is stress-detectie. Dit helpt medewerkers meer inzage te krijgen in de ervaringen van stress bij cliënten. Daarnaast zijn een aantal kamers aangesloten op een google Nest-hub. Deze geeft veel autonomie terug aan cliënten en staat ze toe dingen te doen die ze eigenlijk hun hele leven niet hebben kunnen doen. Tijdens corona een pilot gerund met de robot James. Een sociale robot welke middels een lay-dar en IPad rond rijdt en cliënten met familie of begeleiders kon laten bellen. Dit bood met name veel met betrekking tot vermaak maar maakte contact ook een stuk veiliger tijdens corona. Int2: Tessa de plant in dag-structuur. Slimme sensoren in het verlichten van de nachtdienst werkdruk. Int3: Valdetectie welke bijvoorbeeld de nachtdiensten een stuk behapbaarder maakt. Int4: In het ziekenhuis wordt nog weinig gebruik gemaakt van zorgtechnologie in mijn ogen. Hulpmiddelen voor steunkousen/ted kousen worden nog weinig toegepast. Nu vaak alleen nog nieuwe tilliften, camera's en detectie mogelijkheden (val, uit bed stap detectie etc.)
V2.121	Waar ziet u zelf het meest winst voor zorgtechnologieën voor uw doelgroep?
	Int1: Kijk goed naar het nut van technologie in de zorgsetting. Meest vertrouwen in systemen zoals de nest hub, welke helpt met openen van gordijnen, zetten van koffie en dergelijke. Het bieden van dag-structuur. Int2: Dag structuur bieden en rapporteren vergemakkelijken Int3: vergemakkelijken van rapporteren. Slimme sensoren. Int4: Communicatie en vermindering van de fysieke belasting.
V2.122	Waar ligt de werkdruk hoog bij huishoudelijke taken? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Niet van toepassing Int2: Ligt aan de implementatie. Huishoudelijke taken kunnen gedelegeerd worden, indien de zorgmedewerker een te hoge werkdruk ervaart. Int3: De werkdruk ligt vooral in de ADL. Int4: Niet van toepassing
V2.123	Waar ligt de werkdruk hoog bij ADL taken? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Zorgtechnologie zoals rails en bad-brancards zijn hier erg nuttig. Ook wel sprake van bepaalde wasstraten, maar misschien ethisch niet wenselijk. Int2: Slimme sensoren helpen veel in de beperkte communicatie. Maakt ADL taken ook efficiënter. Int3: Sterk groeiende vraag naar. Techniek zoals rails en brancards maken dit fysiek midner zwaar. Het keren van mensen blijft fysiek een zeer belastende taak.

	Int4: Wassen vershconen, mensen op stoelen helpen/mobiliseren. Zwaardere patienten bemoeilijken dit.
V2.124	Waar ligt de werkdruk hoog bij het verstrekken van medicijnen? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Geen antwoord. Int2: Het herinneren aan het nemen van medicijnen helpt significant Int3: Heel erg foutgevoelig. Kost veel tijd en vormt ook problemen in de thuiszorg. Int4: Ca. 1u per dag? Omdat dit vaak via de maagsonde en het infuus gaat neemt dit ook wel wat tijd in beslag. De dubbelcheck bijv. met google glass doen zou tijd schelen, nu moeten collega's bij hun eigen patienten weg om de uitgezette medicatie te controleren bij de collega. Ook het halen van medicatie bij de apotheek/ op een andere afdeling bij onvoldoende eigen voorraad kost best tijd. Je bent van de afdeling af en moet een eind lopen. Soms kunnen we de buizenpost hiervoor gebruiken maar dit zou m.i ook op een andere manier kunnen.
V2.125	Waar ligt de werkintensiteit hoog bij het bieden van dag-structuur? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Entertainment en houvast Int2: Verlagen van persoonlijk contact. Bieden van structuur in een dag. Int3: Vergroten van de zelfstandigheid. Checken of mensen wel medicatie innemen Int4: NVT
V2.126	Waar ligt de werkdruk hoog bij ADL taken zoals het wassen of klinisch observeren? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Rails systemen en bad brancards verhelpen veel fysieke last. Slimme sensoren helpen met dagelijkse monitoring. Int2: Sensoren. Welbevinden wordt gemonitord. Al veel techniek welke ondersteunt en verbetert in de ADL. Met name met betrekking tot welbevinden. Voorbeeld: Tessa de pratende plant welke met clienten praat. Int3: ADL taken blijven sterk groeien. Zoals wassen en keren op bed. Daarnaast is dit ook het observeermoment, wat het lastig maakt om dit te deligeren. Int4:Vergelijkbaar als voorheen. Vooral bij zwaardere patiënten gaat dit lastig. Klinisch observeren kent überhaupt een hoge werkdruk bij algemeen ziekenhuis.
V2.127	Waar ligt de werkdruk hoog bij het verstrekken van eten? En kan zorgtechnologie hier iets bij betekenen?
	Int1: Service robots zouden kunnen helpen met uitserveren. Wanneer er met een grote groep gegeten gaat worden kunnen autonome robots eten rond gaan brengen. Int2: Een echt piekmoment. Een uitserveer robot is hier functioneel. Int3: Een echt piekmoment. Een uitserveer robot is hier functioneel. Int4: Een echt piekmoment. Een uitserveer robot is hier functioneel
V2.128	Hoe ziet u de toekomst van zorgtechnologie binnen uw organisatie?
	Int1: Meest vertrouwen in systemen zoals de nest hub en slimme sensoren, welke helpt met openen van gordijnen, zetten van koffie en dergelijke. Het bieden van dag-structuur. Int2: Veel diversiteit tussen groepen. ADL zorg zal niet goed overgenomen kunnen worden, door vele doeleinden. Het meten van vitale functies. Kan ook veel betekenen als het gaat om sociaal contact. Dag-structuur, waak-gerelateerde taken zoals monitoring over een langere tijd. Int3: Meer sensoren en dergelijke. Meer online contact met thuiszorg. Meer sociale robotica. Gebruikmaken van spraakmemo's en dergelijke. Metingen geautomatiseerd middels sensoren en ehealth. Veel preventief handelen via bigdata. Int4: Ik denk dat bijvoorbeeld eten delen (op de gewone afdelingen) zou kunnen met een robot oid. Net zoals dat tegenwoordig ook al in restaurants kan. Ook het draaien in

	bed zijn al mogelijkheden voor met een laken dat zelf draait bijv. of evt. een bed dat kan kantelen.
V2.129	Denkt u dat zorgtechnologie de primaire oplossing is tegen het zorgmedewerkers tekort?
	Int1: Verwacht dat er heel veel te winnen is. Veel vertrouwen in slimme sensoren welke detecteren en daar conclusies uit trekken. Onwenselijk dat zorgmedewerkers zelf het contact met de cliënten gaat verliezen. Cliënten worden ook liever gewekt door een mens dan door een robot. Int2: Zorgmedewerkers kunnen niet vervangen gaan worden. Techniek blijft en gaat wel een primaire rol in de zorg spelen. Door technologie mensen langer thuis, autonomer. Vaak ervaren mensen de thuissituatie als fijner. Int3: Met name in efficiënter werken. Meer datadriven gaan werken. Int4: Ik denk het wel, ik denk dat het ook moet om te zorgen dat we de zorg die nodig is kunnen blijven leveren. Maar het lastige si om iedereen mee te krijgen, die weerstand gaat veel tijd in zitten. Maar iedereen is nodig om technologie ook werkelijk zinvol te maken. Dus daar moet je ook mankracht in investeren.
V2.211	Heeft uw organisatie al eens met zorgrobots gewerkt? Wat was hier uw ervaring mee? Hoe reageerde de medewerkers hier op? Hoe reageerde de cliënten hierop?
	Int1: Gebruik gemaakt van robot 'James' , middels lay-dar door de ruimte reed en bij clienten langs gaat. Werkte goed mbt corona, onberekenbaar gedrag van patiënten bemoeilijkt gebruik. Lastig voor medewerkers om mee om te gaan. Int2: Tessa de pratende plant. Helpt met het bieden van dagstructuur. Herinnert aan het innemen van medicijnen en dergelijke. Int3: Ja, met de sociale robot Sara. Hier reageerden patiënten opvallend goed op. Int4: niet van toepassing
V2.221	Hoe kan een menselijke zorgrobot iets betekenen bij het tegengaan van werkdruk en werkintensiteit?
	Int1: Met name in de dag-structuur. Vermaak en entertainment. Geeft medewerker ruimte in druk schema. Int2: Met name in de dag-structuur. Vermaak en entertainment. Geeft medewerker ruimte in druk schema. Daarnaast het meten van vitale functies dat vaak moet gebeuren. Int3: Met name in de dag-structuur voor de bewoner. Het doen van sommige metingen van de zorggebruiker. Helpen in het bewaren van de autonomie. Meldingen en herinneringen helpen hier veel. Int4: Hangt een beetje van de mogelijkheden van deze robot af. Ik denk dat ze wel een bijdrage kunnen leveren bij het in beweging brengen van de patienten en ook wanneer patienten alleen liggen of onrustig zijn. En ook voor patienten die misschien wat in de war zijn op gebied van tijd en plaats. Omdat patienten op zaal liggen met andere patienten zou het wat minder van toepassing kunnen zijn.
V2.222	Naar uw mening, wat voor soort taken zou een menselijke zorgrobot over kunnen nemen?
	Int1: Inschatten van gedrag (in combinatie met slimme sensoren). Het bieden van afleiding. Enkele huishoudelijke taken. Int2: Inschatten van gedrag (in combinatie met slimme sensoren). Het bieden van afleiding. Enkele huishoudelijke taken. Int3: Met name in de dag-structuur voor de bewoner. Het doen van sommige metingen van de zorggebruiker. Helpen in het bewaren van de autonomie. Meldingen en herinneringen helpen hier veel. Uitdelen van eten. Voeren van mensen is nog discutabel Int4: Vervoer van patienten, van eten, van medicatie etc. Het gaat vaak om grote

	afstanden en veel tijd dat je weg bent. Dit zou een robot goed op kunnen vangen. Ik stel zo voor dat je intikt waar de robot heen moet, daar legt de medewerker de benodigde zaken in het 'mandje met deksel'en stuurt hem weer terug naar de afdeling. Idem met eten ophalen van de keuken en uitdelen aan de patienten; tik het in en de robot gaat en wenst de patient ook nog eet smakelijk en zorgt ervoor dat de patient lekker zit, zo niet wordt de vpk geactiveerd om patient rechtop te zetten.
V2.231	Welke nadelen ziet u bij het gebruik van menselijke zorgrobots?
	Int1: Duurbaarheid van zorgrobots, hoe lang blijft het interessant als afleiding. Tot in hoeverre kunnen sociale robots de juiste keuzes maken in zorgsituaties. Int2: Belangrijk dat er zicht is op de zorgvrager. Vergt veel flexibiliteit in het handelen. Docentperspectief: studenten vinden het soms lastig. Trekken na verloop van tijd wel bij als ze meer over de techniek weten. Int3: Puur ethische reserveringen. Werkt het dehumaniserend om mensen door een robot te laten voeren. Int4: Het kan niet alles vervangen, je bent als vpk nog steeds nodig. Je moet zelf als vpk goed weten hoe het werkt en dit ook kunnen uitleggen aan de patienten en diens naasten. Dit kost weer tijd, dus hoeveel tijd hou je er netto aan over
Bv1	Heeft u nog aanvullingen op de voorgaande vragen?
	Int1: Probeer zoveel mogelijk voeding te houden met de werkvloer. De robot zou ook zo autonoom mogelijk. Dit omdat zorgmedewerkers al snel het nut niet meer in zien van techniek, als het ze in het begin meer tijd kost dan ze denken dat het oplevert. Int2: Techniek biedt veel autonomie, en dat is belangrijk in de huidige setting van zorg. Er is geen concensus tegen techniek (onder studenten), maar het levert wel interessante gesprekken op over ethiek. Int3: Robot vinden mensen mogelijk intimiderend. Wanneer een robot toegepast wordt, moet deze wat ontwapenends hebben en zeker niet op een mens lijken. De Sara is hier een goed voorbeeld van. Int4: Zorgtechnologie is zo breed wij als verpleegkundige weten soms niet eens wat er allemaal mogelijk is om ons werk te vergemakkelijken. Ik denk dat het belangrijk is dat bijv. een zorgtechnologisch manager/ innovatie manager heel erg het contact met de werkvloer zoekt. Om samen te kijken waar verlichting nodig is en welke technologische hulpmiddelen hiervoor beschikbaar zijn. Vooral die samenwerking zal de acceptatie en het nut van technologie vergroten.
Bv2	Bijvangst
	Int1: Zorgmedewerkers zijn in de zorg gaan werken om zorg te bieden. Dus het efficiënter van sommige simpele saaie klusjes zou zorgmedewerkers ook toestaan om hun tijd nuttiger te gebruiken. Spraakmemmo's zou heel veel tijd schelen in plaats van veel rapporteren. Bijvoorbeeld ADL-taken welke ook veel diagnostiek kent gaat hierdoor sneller. Clienten reageerden heel erg goed op de robot. De mensen die er last mee hadden waren primair de medewerkers Int2: Piekmomenten zijn eten uitserveren, verstrekken van medicatie en ochtend ADL taken. Als een verzorger in haar eentje 12 cliënten moet voeren is dat niet veel mensvriendelijker dan wanneer dit wordt gedaan door een robot. De persoonlijke look van robots hielp ook heel erg in de acceptatie (mensen zijn ook gek op Wall-e). Mensen reageerden echt heel goed op een robot die met ze praat. Int3: Int4:

Appendix 5: Validation method

ER1: Assertiveness warranted;

Is the robot capable of the level of conversation that is required for this task?

Does the robot have to gather information through conversation for this task?

ER2: Appearance warranted ;

To what extend does the appearance negatively influence it's ability to do the task?

Does the robot need a certain height in order to do this task?

ER3: Autonomy of the SSR warranted;

To what regard can the robot autonomously full fill this task?

Would the robot be able to do this task without healthcare workers being in the facility?

ER4: Task complexity level (Intelligence);

How difficult are the tasks in terms of abstract processing?

How difficult are the task in terms of adaptability?

ER5: User-operation difficulty;

How hard would it be for healthcare workers to operate the robot in regards to this task?

To what regard could somebody with little to no schooling still succeed at setting the robot to do this task?

M1: Degrees of freedom;

Does the robot have the degrees of freedom required to complete this task?

M2: Load limits for the effectors ;

Do the load limits exceed the limitations of the robot-platform?

M3: End effector grips;

Can the bebionic hands perform the grips that are needed for this task?

M3: Task complexity (Movements);

How many different movements are needed to complete this task?

How hard are the movements that should be done to complete this task, in terms of raw physical ability and complex movements?

S1: Occurrence of malfunction;

How often would a programmed robot fail at doing this task?

How many moments are there during this task at a human could make a mistake

S2: Severity of malfunction;

How bad would it be if something went slightly wrong during this task?

How bad would it be if something went very wrong during this task?

S3: Detection of malfunction;

To what degree are the mistakes made during this task visible to see by by-standers?

How long would it take for somebody to check on the robot during the task?

SE1: Dehumanization of the client;

To what degree are other technologies already doing this specific task?

To what degree is this task currently done by humans?

SE2: Gain of autonomy for the client;

To what degree does this task being done by a robot increase the empowerment of the client?

To what degree does this task being done by a robot take away from the clients autonomy?

SE3: Unburdening effect of healthcare workers;

How much time does this task consume?

What is the physical strain of this task?

Appendix 6: Validation results

	1	2	3	4	5		1	2	3	4		1	2	3		1	2	3	
HK1.1	5	5	5	5	5	25	4	5	5	4	18	3	5	4	12	5	5	5	15
HK1.2	5	5	5	5	5	25	5	5	5	5	20	3	5	4	12	5	5	5	15
HK1.3	5	5	3	2	5	20	5	5	5	4	19	5	5	5	15	5	5	5	15
HK1.4	5	5	3	2	5	20	5	5	5	5	20	2	3	5	10	5	5	5	15
HK1.5	5	5	3	2	5	20	5	5	5	5	20	5	5	5	15	5	5	5	15
HK1.6	5	5	3	2	5	20	5	5	5	4	19	2	3	5	10	5	5	5	15
HK2.1	5	5	5	4	5	24	5	5	5	5	20	3	5	5	13	5	5	5	15
HK2.2	5	5	5	3	5	23	5	5	5	5	20	3	4	5	12	5	5	5	15
HK2.3	5	5	4	3	5	22	5	5	5	4	19	3	3	5	11	5	5	5	15
HK3.1	5	5	4	5	5	24	5	5	5	5	20	4	5	5	14	5	5	5	15
HK3.2	5	5	4	5	5	24	5	4	5	5	19	4	5	5	14	5	5	5	15
HK3.3	5	5	4	5	5	24	5	3	5	5	18	4	4	5	13	5	5	5	15
HK3.4	5	5	4	4	5	23	5	5	5	4	19	4	3	5	12	5	5	5	15
HK3.5	5	5	4	5	5	24	5	5	5	4	19	4	3	4	11	5	5	5	15
RA1.1	4	4	5	4	5	22	5	5	5	5	20	4	4	5	13	5	5	5	15
RA1.2	4	4	5	2	5	20	5	5	5	5	20	4	2	5	11	5	5	5	15
RA1.3	5	4	5	5	5	24	5	5	5	5	20	5	2	4	11	5	5	5	15
RA1.4	5	4	5	4	5	23	5	5	5	5	20	4	2	4	10	3	5	5	13
RA2.1	4	4	5	5	5	23	5	5	5	5	20	4	4	5	13	5	5	5	15
RA2.2	5	4	5	5	5	24	5	5	5	5	20	5	2	4	11	5	5	5	15
RA2.3	4	4	5	4	5	22	5	5	5	5	20	4	3	4	11	3	5	5	13
DS1.1	2	4	5	2	5	18	5	5	5	5	20	4	5	5	14	4	5	5	14
DS1.2	2	4	5	2	5	18	5	5	5	5	20	2	5	5	12	5	5	5	15
DS1.3	2	4	4	2	5	17	5	5	5	5	20	3	4	5	12	3	5	5	13
DS2.1	5	4	5	5	5	24	5	5	5	4	19	5	5	5	15	5	5	5	15
DS2.2	5	4	5	5	5	24	5	5	5	4	19	5	5	5	15	5	5	5	15
DS3.1	5	2	4	5	5	21	5	5	5	5	20	5	5	5	15	4	5	5	14
DS3.2	3	3	3	5	5	19	5	5	5	5	20	5	5	5	15	3	5	5	13
DS3.3	2	4	3	3	5	17	5	5	5	5	20	5	5	5	15	3	5	5	13
DS3.4	5	4	5	5	5	24	5	5	5	5	20	5	5	5	15	5	5	5	15
DS4.1	4	3	5	5	4	21	5	5	5	5	20	5	5	4	14	5	5	5	15
DS4.2	4	3	5	5	4	21	5	5	5	5	20	5	5	4	14	5	5	5	15
DS5.1	4	3	5	5	4	21	5	5	5	5	20	5	5	4	14	4	5	4	13
DS5.2	4	4	5	5	4	22	5	5	5	5	20	5	5	4	14	4	5	4	13
DS5.3	5	5	5	2	4	21	5	5	5	5	20	4	5	5	14	5	4	4	13
DS5.4	3	3	5	3	4	18	5	5	5	5	20	4	5	4	13	4	5	4	13
PI1.1	5	5	5	5	5	25	5	5	5	5	20	5	4	5	14	5	5	5	15
PI1.2	5	5	5	5	5	25	5	5	5	5	20	5	4	5	14	5	5	5	15
PI1.3	5	5	5	5	5	25	5	5	5	5	20	5	3	5	13	5	5	5	15
PI1.4	5	5	5	5	5	25	5	5	5	4	19	5	3	5	13	5	5	5	15
PI1.5	5	5	5	5	5	25	5	5	5	5	20	5	4	5	14	5	5	5	15

	1	2	3	4	5		1	2	3	4		1	2	3		1	2	3	
PI1.6	5	5	5	5	5	25	5	5	5	5	20	5	5	5	15	5	5	5	15
PI2.1	3	2	3	2	4	14	5	5	5	5	20	4	3	5	12	1	4	5	10
PI2.2	3	2	3	5	5	18	5	5	5	4	19	5	2	5	12	4	4	5	13
PI2.3	3	2	3	5	5	18	5	5	4	4	18	5	1	5	11	1	4	5	10
PI2.4	3	2	2	4	5	16	5	5	5	5	20	4	2	5	11	1	4	5	10
PI3.1	3	2	5	5	4	19	5	5	5	3	18	5	3	5	13	5	5	5	15
PI3.2	3	2	5	4	5	19	4	5	4	4	17	5	2	4	11	5	5	5	15
PI3.3	3	2	2	4	3	14	5	5	5	5	20	5	2	4	11	4	5	5	14
PI3.4	3	2	2	5	5	17	5	5	5	5	20	5	2	3	10	2	4	5	11
PI4.1	5	5	3	3	2	18	5	5	5	5	20	5	3	5	13	5	5	5	15
PI4.2	5	5	3	5	5	23	5	5	4	5	19	5	3	5	13	5	5	5	15
PI4.3	5	5	3	4	4	21	4	5	5	3	17	4	3	5	12	5	5	5	15
Total	225	213	224	216	251		262	262	262	249		228	200	249		233	259	261	

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