Health Professionals' Views on the Use of Social Robots with Vulnerable Users: A Scenario-Based Qualitative Study Using Story Dialogue Method

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Abstract—**We used the story dialog method (SDM) to gather the viewpoints of health professionals about the use of social robots in the home and healthcare services with vulnerable users. SDM consists of participants bringing stories that are discussed together. The aim of the study was to address universal design and accessibility issues with robots in specific use situations. Three social robots were used for this purpose in four stories: TIAGo, Romibo and robot companions. SDM method was used in two workshops with eight participants (33 invited, 12 recruited, and 8 participated in the end). The participants uncovered issues regarding ethics, responsibility, use of data, infrastructure, design, and user concerns based on provided stories and own experiences. These issues provide important aspects that should be considered when using robots with vulnerable users and ensuring that a robot is usable by as many people as possible. The main contribution of the paper is introducing the SDM method to Human-Robot Interaction community, as well as findings around universal design and accessibility of robots, in order to create more inclusive social robots.**

I. INTRODUCTION

The use of social robots is growing rapidly in the healthcare context due to a shortage of healthcare professionals. Furthermore, robots are and will be introduced into everyday life to complement daily activities as well as replace human companionship, if necessary, in homes with people of all ages. Using social mechanisms such as speech and gesture, social robots allow people to interact with them [1]. Similarly, socially assistive robots can be used to teach and coach people in different areas. For instance, these robots can be used to teach people with autism spectrum disorder to understand social cues [2]. These social mechanisms can also make it easier for people to interact with robots and lower the barrier for including robots in more activities.

Different perspectives have been considered when studying robots, such as design, engineering, and informatics. Recent Human-Robot Interaction (HRI) research argues that the next years should focus on teleoperated robots and teleoperations, rather than on fully autonomous robots [3]. They argue that the focus should shift on creating interfaces that are easy to (tele-)operate by novice users, or users with low digital skill when it comes to robots, including vulnerable users [3]. In this way, if non-experts users are able to (tele)operate robots, various technical challenges will be avoided [3]. This implies that many more people may be using a robot and raises concerns regarding accessibility and universal design requirements that must be fulfilled. Thus, we were interested in collecting opinions and feedback from groups that might be affected with the introduction of social robots into their work or home environment, such as health care personnel working with vulnerable users. We wanted to discuss potential use cases. We were interested in how including these voices would provide insight into how to make robots more inclusive and universally designed. This information would be used to see how existing guidelines would apply to robots in these situations. To achieve these goals, we focused on healthcare professionals' attitudes towards the design of robots when they would be used with vulnerable users. Healthcare professionals are an important group to focus on since healthcare education (at least in the Norwegian context) is currently lacking courses or other types of undergraduate education on how to deal with advance technologies, such as robots, as part of home- or healthcare services, since knowledge of these technologies is not the main core of the education. Recent research also shows that Norway will be in need of an additional 41 000 practical nurses by 2030 [4], while Statistics Norway indicate a lack of 28 000 nurses and 18 000 health personnel by 2035 [5].

Thus, we conducted two workshops and two different online surveys (19 respondents, respectively 35 respondents) with healthcare professionals as part of our data collection. All data collection addressed Universal Design of social robots, from different perspectives. This paper concerns the presentation of the findings from the data collected through the workshops. We ran the workshops using the Story Dialog Method (SDM), a method that has not been earlier used in HRI studies. The aim of the study was knowledge development around the theme: "Robots and Vulnerable People," specifically focusing on Universal Design and accessibility related to social and assistive robots. The research question addressed was: *How do healthcare professionals view the use of social robots with vulnerable users in home- and healthcare? What are their views regarding these robots' universal design features, such as inclusion and accessibility?* This paper presents background on the method, how the workshop was run, findings, and implications for further research.

II. UNIVERSAL DESIGN

Universal design is the idea that one should create something (a product or service) that is usable by as many people as possible. The argument for the universal design approach is

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that it removes the needs for special solutions that often are under-maintained and potentially stigmatizing. Connell and colleagues [6] defined seven principles of universal design: 1) equitable use, 2) flexibility in use, 3) simple and intuitive, 4) perceptible information, 5) tolerance for error, 6) low physical effort 7) size and space for approach and use.

Early references to universal design and robotics discuss ways that universal design can be applied to environments so that a robot more easily use the environment. Matsuhira and colleagues [7] presented their modified set of the seven principles with a focus that objects and rooms in an environment should also be usable by robots, for example by providing geometric markers so a robot can know where to place itself or using different fasteners for that do not require the precision of bolts. Similarly, others suggested that the guidelines could and should be adapted and applied to social robots, especially if these robots shall be used by a large number of users, including vulnerable users [8], [9]. Kim and colleagues [10] interpreted the original guidelines and showed how the system could work for wheeled robots and a robotic arm that is mounted on a wheelchair. A different focus on making the environment universally designed is presented by Tan and colleagues [11]. They argued that universal design can be beneficial to including robots in an environment and suggested proposed that how inclusive a robot is to the environment is a function of the complexity of the robot and the complexity of the environment. This implied that the either the robot or the environment could be modified to make the environment inclusive. They proposed guidelines for designing environments based on observability, accessibility, manipulability, activities to be performed, and safety.

Since the universal design guidelines were primarily targeted at environments, it makes sense that the initial focus would be on environments, especially if they are environments that only robots would be working in. But the guidelines are applicable to ICT as well. When robots are expected to interact with humans, the interface to the robot (be it speech, a remote control, or something else) needs to be usable by as many people as possible who wish to interact with the robot. A common way to make non-robotic ICT technology, such as web pages on a computer or mobile phone, accessible is to follow the Web Content Accessibility Guidelines (WCAG) [12] to make information on a web page or an application accessible. If a web page follows the WCAG, then everyone visits the same web page and people using assistive technology, such as a screen reader, receive the same information as those that do not. Thus, a web page that is "universally designed." The WCAG focus on screens and web-based content. It can be adapted to other types of computer applications, but its focus was never on robots. Qbilat and Iglesias [13] proposed guidelines to work with a robot with a touch screen. They later adopted the WCAG for socially assistive robots [14]. These guidelines were tested out with a newer robots [15] with some success. The WCAG or the modified guidelines from Al-Qbilat are useful for discovering *some* types of accessibility problems and making sure a solution is compliant. It is a first step in making sure that a solution is universally designed. It is still necessary to involve people with disabilities in testing out the solution ensure it is universally designed and to help in informing what a solution would look like. Activities like workshops can be a good way for gathering this information.

III. The Story Dialog Method

A. Study design

Using Story Dialogue Method (SDM), we conducted two workshops. SDM draws from constructivism, feminism, critical pedagogy, and critical social sciences [16], [17]. The method is both a data collection and analysis method. This method is based on a structured dialogue that uses participants' own experiences as triggers for dialogue and discussions about certain topics. In our study, the topic of the SDM workshops was "Robots and Vulnerable Users."

TABLE I. Overview of the participants [18].

Method	**Participants overview**			
	Facilitators	***# Invited***	***# Interested***	***# Participated***
Workshop 1	2 (2 F: DS main, ZP observer)	16	12 (2 M, 10 F)	5 (1 M, 4 F)
Workshop 2	4 (3 F, 1 M: DS main; ZP, TS, and 1 master students as observers)	17	9 (All F)	3 (All F)
TOTAL	6 (4 Unique)	33	21	8 (1 M, 7 F)

B. Participants

The participants were recruited through convenience sampling and using the snowball effect. All of them had a healthcare background or worked in a health-related field. 33 participants were invited, and 21 responded positively to the initial invitation. However, in the end, only 8 participants took part in the study, and 4 different facilitators (*n*=12). Some of the participants had to cancel at the last minute due to schedule collisions, sickness, or personal reasons. The breakdown of those that were invited, interested, and participated is detailed in TABLE I.

C. Data collection and analysis

SDM was used for data collection during workshops. In workshops based on SDM, for example, participants will gain insights related to a specific theme, often when a change within an organization is desired to take place. In the past, SDM was primarily used in the healthcare domain, and in the education domain, but currently the method is also being used increasingly in Human-Computer Interaction domains [19], [20]. Two of the authors (DS and ZP) had experience using this method previously. Rather than having the participants knowing each other or have experience with robots since before, the authors decided to use this method because it allowed them to arrive at different insights about the given theme through conversations based on a structured dialogue. Each workshop took about 3 hours to complete. Audio and video recordings of the workshops were made. Verbatim transcriptions of the workshops were made using the Whisper service at University of Oslo, Norway. The transcripts resulted into approximately 100 pages of text, and approximately 36 000 words. The data was analyzed through SDM, since SDM is a method for collecting and analyzing data. The main facilitator clarified during the introduction that no prior experience with robots was required to participate in the workshop. To provide context and demonstrate how different robots might look, an image depicting a variety of social and/or assistive robots was also shown to participants. Fig. 1 provides an example of the robot images. The workshops were structured as follows: **1) Storytelling, 2) Reflection circle, 3) Structured dialogue, 4) Reviewing the story records.** Each part of the structured dialogue included a specific set of questions that guided the dialogue and helped the participants to reflect around the stories chosen. The set of questions was shared online with all the participants and was always available, during the workshop on a screen.

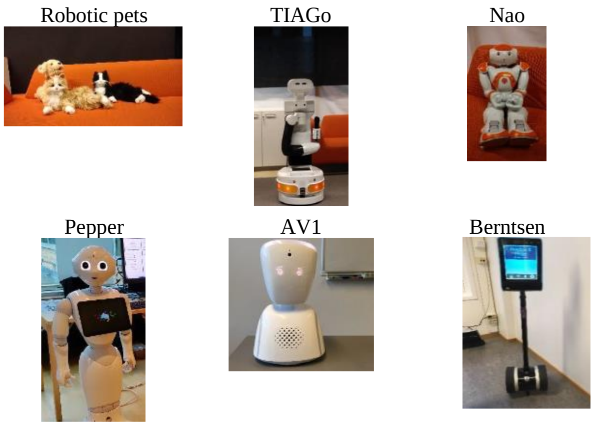

Figure 1. Different types of robots shown to the healthcare professionals during workshops

D. *Ethical considerations*

The study was registered to the Norwegian Center for Research Data (NSD) for ethical assessment (#972068) and to the Regional Committee for Medical and Health Research Ethics (REK) (#494243). Participants received written and oral information about the project and had the possibility to ask questions. The participation was voluntary. All signed an informed consent form. Participants could end their participation without explanation or consequence for them, at any time. All the information about the participants was treated anonymously. The Norwegian Computing Center provided a dedicated secure area for the data to be safely stored.

IV. Scenario-Based Stories

Since participants may not knew each other or have experience with robots, there was a possibility that someone might not have a story related to social robots, or might not want to share a story. So, we adapted SDM by creating stories that participants could use as a starting point. Four stories were provided. Each story raised specific issues and involved the use of social robots with vulnerable users. **Story 1** referred to a robot monitoring the health of an 85-year-old woman and her opinions about it. This story presents a range of ethical dilemmas for potential vulnerable users of social and assistive robots, home- and healthcare professionals, and researchers and academics in the fields of design, engineering, and healthcare, as well as Universal Design. **Story 2** referred to the use of a robotic toy used with autistic children in therapy sessions without conforming with the Medical Device Directive. This was passed on a real-world scenario discussed in Norwegian media [21]. **Story 3** referred to the use of robotic pets as companions at a care center for elderly people with cognitive decline. Also based on real world events and presents ethical dilemmas for different people involved. **Story 4** referred to robots using sign language to interact with a deaf tourist on vacation in a different country. This story was on previous research [22] and highlighted possibilities for using a robot as an assistive technology. Participants received the stories in Norwegian and English one week before their workshop would start. We asked participants to select the story that they could relate to most. Those who had previously dealt with robots were also offered to bring their own story related to the given theme. Characteristics of each story are provided (TABLE II.) The full stories are documented in a project report [18].

TABLE II. Overview over the Characteristics of the Stories

	Story 1	**Story 2**	**Story 3**	**Story 4**
Robot	TIAGo	Romibo	Robotic pets	TIAGo
Robot capabilities	Able to help with home chores, acting as a reminder, social interaction	Speech interaction, tangible interaction	Simulate a pet through: Moving head, blinking eyes, moving legs and paws, making pet sounds	One-armed robot able to commnicate through sign language. Has only one gripper.
Robot equipment	Cameras and sensors	A screen used as eyes	Actuators moving the robot pet's bodies	Robot gripper
Vulnerable user	Elderly people	Children	Elderly people	Deaf people
Persona's characteristics	Impaired vision, sadness, depression or loneliness;	Autism	Cognitive decline	Cannot interact through speech, people that are using sign language
Context of use	Home care	Healthcare settings (therapy sessions)	Care center for elderly people	Semi-public space (Coffee shop)
Issues addressed	Multimodal interaction, accessibility, privacy, personalized services	Robot toys used in health therapy sessions	Ethical dilemmas, accessibility, and multimodal interaction	Inaccesible services for deaf people, universal design of robots, accessibility of robot interaction

V. Findings

We start with presenting the participants' experience with robots. Then, we present some of the different challenges they identified during the workshop.

A. *Experience with robots and vulnerable users*

Most participants had limited or no experience with robots, especially socially assistive robots, but there were a few exceptions. One participant explained that she had previous experience with a feeding robot: a robot used with vulnerable users and operated by the patient's eye movements, and with a joystick, to feed themselves. The participant explained that the healthcare professionals were initially skeptical towards this robot, but once they saw a demonstration of the robot and how it was used in practice, they could see the value in it: the vulnerable user could take as long the user needed to eat a meal without being dependent on a care professional's tight schedule. The participant explained: "*Their reaction before ... was fear and a very negative attitude, where they [care professionals] assumed that this robot would take work from them. ...But when we demonstrated the application, their negative attitude towards it changed to positive*." Similarly, another participant explained her experience with social robots used with children with autism. One participant had limited experience with robots transporting different items in the hospital's corridors and another participant had experience only with vacuum cleaner robots. However, this participant was aware of the need of these other kind of robots to be used in elderly care due to the shortage of personnel. However, participants did have diverse experience working with vulnerable users: working with elderly people, women and immigrant people, people with autism, children, people with dyslexia, people with attention deficit hyperactivity disorder (ADHD), deaf, and blind people, people with development disabilities, and people that needed care in their homes or in hospital settings. Further, the participants agreed that robots would play a significant role in healthcare in the future. They posited that robots would help vulnerable groups, reduce the burden on the healthcare system, and may improve their quality of life. Despite this, participants also named challenges with incorporating robots into healthcare. In the participants' opinion, the challenges include 1) ethical dilemmas, 2) infrastructure considerations, 3) user considerations, and 4) design considerations. We present each of these next.

B. *Ethical considerations*

Participants unanimously agreed that the robots should not replace health care professionals. Participants agreed, however, that robots can be useful in training purposes, such as for teaching social skills to children with autism in the absence of teachers. In addition, participants admitted that more responsibility was placed on the user when using these advance technologies. This could be dangerous. When banks transitioned from full-service to self-service and online banking, they promised customers that their in-person clerks and tellers would still be available. However, one participant point out bank customers often must deal with technology on their own, such as self-service and chatbots. Using this analogy, the participant reminded us that vulnerabilities may arise when introducing new technologies. The technology could be used in a different way than intended from the start. This was also one of the concerns raised by participants about the use of these social and assistive robots in home- and healthcare.

Participants expressed concerns regarding the misuse of these robots. Comments from participants highlighted how these robots may be useful in certain contexts and purposes, but there is a risk that the robots will be used inappropriately if researchers fail to communicate and inform users in which contexts and settings these robots are not relevant or useful. Care receivers and users may also be adversely affected when the robots are used. Another participant stated that humans develop and interact best with things that are "natural" to them. Here, that would mean interacting with people, not with technology. Other ethical considerations participants mentioned included: the importance of safety, data security and privacy, how the data would be used, and preserving the right to privacy when using robots in the home. For instance, participants were concerned healthcare professionals might be unable to explain what happens with personal data collected by the robot: "*the people who are working in healthcare at the end, are unable to answer the questions on what does the robot have to do with the information that the robot is gathering about others, like visitors and grandkids and so on*.".

Who is responsible for the robot placed in the home of a care receiver or vulnerable person? One healthcare professionals explained: "*...it is very important to know who has placed this robot in my home. Is it me who has bought it? Then I am responsible for it. But is it so that health care staff have come in and put it out, and tried it out, and are responsible for maintaining everything? ...if I [the patient] have placed the robot on my own, then you cannot expect that staff... It is this legal threshold, who takes responsibility, and then the staff can help to be nice. But if it goes wrong, the patient is injured, and the staff has been involved in it, then they [the staff] can answer for it and lose their certification."*

Another participant concurred: *"It also concerns healthcare professionals. They do not know how to use this robotics, and who is responsible using this, and what kind of information has been used and where to collect how to collect and the responsibility."*

One participant was concerned about the robot security, the data it collects, different contexts for use, and the patient's physical safety: "*With regards to knowing my responsibility, if I am the healthcare professional, I have to make sure things are secure. Let's say, for example, with regards to the data that the robot will be gathering, how shall I take care of those? And, also, with regards to the security of my patient. ... different people who are visiting my patient, for example, that's some sort of security, safety as well. It also depends on ... if the patient is in their own home or in the nursing home, of course, there will be different needs for programming maybe."*

One privacy issue was using a robot in a private space, such as a home**. "***When the robot collects information and recognizes if there is a camera, especially when people come to visit, it is a problem that other people, both staff and other residents, or people on visit can be filmed without them knowing. They feel very uncomfortable with it and don't know who should have access to this. It can make people feel isolated, that people just stop coming there."*

Another participant mused, "*If I had a robot in the home, with whom would it share the information?"*

Another concern pointed out was whether the integration of social robots in the home care services will eventually lead to increased loneliness, and less social support from humans (family members and healthcare professionals). Similarly, another participant was afraid of a *"being stuck in the home with a robot that does not function."*

One of the last ethical concerns regarded sustainable production of robots. The participants wished that robots would last, update themselves, and not need to be replaced every three years: "*So therefore they have to plan this lifetime of a* *product how long it should last. But when it comes to robots, with mobile phones, with smartphones to bring robots together they contain plastic, lots of metals, they contain different things that we don't have infinite resources. So therefore, we should think a little bit about how to design these robots so that they are more durable in the long run."*

C. Infrastructure considerations

A question raised during the workshops was how these robots should be included within these systems: whether they should be offered as a service by municipalities or the state? Should care recipients should be able to purchase them? This linked back to the responsibility questions raised in the previous section, especially in cases where the robots are bought privately and used in a care process. Some participants were skeptical toward robots and advocated for healthcare professionals to be physically present during the care process. One participant pointed out that robots are a crucial part of the future of healthcare. Another participant mentioned that he began thinking "robotical thoughts," due to the workshop. In his view, robots could help society move forward. To make good care decisions, society needs to understand what robots can and cannot do, according to the participant. Hence, he agreed that robots can offer many advanced and beneficial features. Despite this, he was not in favor of robots replacing all human care with them. In addition, another participant stressed the importance of understanding one's role and tasks as healthcare professionals, in addition to identifying what tasks can be automated, and which should not.

When discussing story choices, one participant mentioned their studies did not prepare them to deal with these kinds of technologies: *"we as healthcare professionals have to dedicate our times to learn about this technology, because now we must be really prepared. We are facing new kinds of technology, because we don't get it at school. And we don't have any continuing education on how to use this technology. Somebody just comes up and says, 'There is a robot,… you can use it in your practice.' … Somebody has to teach us how to use it, where to use it."*

Another concern that the participants pointed out is that there is a shortage of nurses, and healthcare professionals in general. This also adds complexity on how to dedicate time to learn these technologies, when they are already too few: *"We have lack of and shortage of nurses and healthcare professionals, or shortage of professionals who works in the nursing home, for example. So how are they going to really use their time sufficiently to use this technology?"*

This echoed a point of other for education within this domain: *"the need for the helpers to learn the technology, to feel confident that what the technology is doing, to be able to answer questions about what the technology is doing"*

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The participants seemed generally positive towards using robots. Once they could learn and use it, they predicted it would be a great help: *"I know once we learn this technology, it is going to be a great help for us. Not only for the vulnerable group, for the elderly people, but also for us. It's going to contribute a lot to our workload, but we must know how to use it, when to use it, where to use it, who's going to use it, how are we going to use it."* However, some participants were concerned about encountering small technical challenges all the time once the robot is introduced. She made an analogy to using zoom and the blur filter, and how small technical details sometime may take a lot of time from the main tasks. Further, robots used in healthcare should also have a backup battery and be easy to recharge or the charging station that is placed in a practical way that is not in the way.

D. User considerations

The use of stories was a natural way to raise user aspects in the workshops. Some participants debated whether the vulnerable user is the care receiver, the healthcare provider, or both. All participants stressed how crucial it was to involve the user participants. Participants also raised the issue of how technology may undermine trust in healthcare if it does not work as intended. According to one participant, technology that does not work well from the start should not be used with vulnerable users. Otherwise, we may undermine the vulnerable users' trust in care providers and care services. Social and assistive robots should be thoroughly tested before being used with vulnerable users. Moreover, social and assistive robots should be adapted to the individuals' contexts of use and meet their individual needs. Similarly, the social and assistive robots should support tasks performed during everyday life, e.g., educational activities for children, social aspects, and functionalities that facilitate a user's daily life. A robot's design should be user-friendly, and early user involvement should be encouraged during the design process. One participant argued that the Story 4 showed that social robots can be empowering, and that it is important that the technology, in this case the robot, understand the user, even if the user only uses sign language: "*to be met and to be understood in a way is more instrumental than social in a way.*" The participant further stated that using robots with vulnerable groups to empower them makes the vulnerable groups seen and would give the groups more control of the situation. Thus, this creates positive experiences for the vulnerable groups. However, the participant pointed out that perhaps the deaf person would prefer to be approached by a person knowing sign language, rather than a robot, but the deaf person might be interested in the novelty of interacting with the robot anyway. For example, in schools where robots are used, children pay attention longer to robots, while the robot can also strengthen the relations with other peers.

Owning a robot, it seems, can also give the owner a higher status amongst peers, regardless of the person having or not having a physical or cognitive disability. The robot raises curiosity amongst others and popularity amongst peers, like having an asset that others do not have. The participant familiar with the feeding robot claimed it gave higher status to the ladies using it when they took it out to a restaurant: "*These ladies were supposed to take the robot with them to the restaurant and go out to eat. And they should not be ashamed of the fact that they use it, they thought it was fancy. And then there was another thing that they also mentioned, … the robot is a status symbol because it is expensive.*"

Further, a participant emphasized the importance of shifting the focus from the robots "taking care of" the vulnerable person to empowering them: "*And it was perhaps a bit the same, I felt, with that story. That here there is something that is made for them that is high-tech and that can give a little more status instead of being the one who is taken care of as in the first story. It feels a bit more inclusive*."

Unfortunately, robots can also be disempowering if the end-users were not involved in their design. One participant claimed that Romibo from Story 2 didn't work because it was not designed with user participation: "… *if you make something with user involvement, I think you can quite quickly come up with something that is dramatically much better than it [Romibo]*." At the same time, user participation in design, especially when it comes to children, or vulnerable groups, is more challenging. It needs to be done on their terms. Her suggestion was to involve the users directly in the design. This will create a more inclusive design process, and thus robot design. What does inclusive design in social robots mean? Participants answered that we need to listen to what the children or other vulnerable users want, rather what the adults or their caregivers say they want. The participants argued for user participation done in the right way and with good grounding in the user. This can be done by asking the users what they wish for, rather than pushing a technology on them.

E. Design considerations

In the workshop, some participants pointed out the importance of taking certain factors into account. For instance, for vulnerable groups, robots should be helpful, facilitate care, and not introduce new challenges. The design should be adapted to the needs of each user. Participants noted tension between designing assistive robots that can be adapted, customized or personalized to the individual while simultaneously meeting the needs of as many users as possible (thus fulfilling universal design principles). Participants suggested universal design as a starting point. That is, universal design is not the whole solution, but the "starting package". Further customization and personalization options should be included in these social and assistive robots. As one participant said: "*I believe that these kinds of robots, they should be programmed with regards to individual needs of the patient*."

Participants recommended buttons that are easy to manage by vulnerable users: "*[buttons] should be easily managed. That's also my concern, especially if the older people. If it's too complex, they will lose their patience or whatever*."

Additionally, robot interface elements should have good icons, big letters, where different features can be adapted according to the users' needs: "*... if it is for the elderly and for those with problems with their eyesight, it has to be good icons, good big letters. ... it has to be adjusted depending on the needs of the individual*".

This customization should also include the language spoken by the user. Similarly, the screen of the robot, if the robot is equipped with one, should provide text in the language spoken by the care receiver. In addition, if the robot can communicate through speech, it should be able to interact in the language of the care receiver, adjust its tone of voice, and adapt to the specific cultural norms of the user: *"With regards to the tone of voice, with regards to the sentences, how is it formed. You know, if I'm going to interact with my robot, I have to have, and I am expecting for a little bit, let's call that, hopefully or... There's a cultural difference there with regards to expectation, with regards to intonation, with regards to, and the clarity of the voice. What kind of voice do I like? Shall I interact with a lady or with a strong robot who has more of a masculine type because he's going to do things that are more masculine for me*."

The participants recommended the robot communicate in the form that matches the user best. The robot should adapt its communication to different users. Of course, this would create interoperability challenges. From a healthcare professional point of view, participants noted that the social robots should be easy to clean: *"If I am to look at it as a health worker, and not as a private person, it is very important that the robot should be easy to clean. Then we always think about hygiene and infections. (...) you have an ongoing infection in the department, it is crucial that it is easy to clean. So it should not be a source of infections."*, "*And then there may be a reason, if you cannot clean it, disinfect it, that it cannot be used for a certain period. And then it is tragic."*

When asked about the robot appearance and the materials used, one participant preferred robots like Nao and Pepper (Fig. 1) due to hygiene. However, one participant argued that the robot should be comfortable to the user, when touching it. Similarly, the robot's smell and the sounds it makes should be considered. "*... it is important for the users that their senses are accounted for and taken care of*."

Three participants said they preferred humanoid robots. One concern on their side was the robots may take away their jobs, and they could be replaced by robots. Another concern was the robots' cost, and who will pay for them. A third concern was the infrastructure for humanoid robots, arguing that smaller robots, such as robot companions or Berntsen (Fig. 1) do not require many infrastructure changes. At home, participants preferred humanoid robots. When asked why, one argued that the robot should meet the expectations of its appearance: "*I was very disappointed when I saw this robot transporting goods at Akershus University Hospital. It warned me that I should move. Then I heard a voice, so I moved and looked around. I did not see anyone and then I got a reminder that I should move from their track. Suddenly I discovered that there was a box on the floor. Then I was a little disappointed. It is a little expectation. If it is something that should resemble our functions, humanoids, then one expects that there should be a little humanoid appearance as well. It is a bit subconscious; I think."* One participant argued humanoid robot looks more realistic than other types of robots. She considered the humanoid appearance of the robot makers her think about something different than just equipment and build a social relation with it. Another participant argued that a humanoid robot speaks more to her. A third participant agreed that it will be easier to interact with a robot if it resembled a human. One participant disagreed with this point of view. She argued that one addresses all kinds of technical devices as if they were humans. For instance, one can find himself talking to a robot vacuum cleaner, or to a TV. She also argued that as the technologies become more and more advanced, we, humans, tend to assign social attributes to these technologies. This is not necessarily dependent on the appearance of the technology.

Another participant, while she agreed with the others, also pointed out choosing a robot is dependent on the context of use. She explained that the Pepper robot was not as appropriate as Nao to be used with children with autism, because of its size might be intimidating. Children with autism needed less stimuli from the robot's appearance, so they can focus on learning and interacting with the robot. Some participants also mentioned that a bigger robot might be more powerful and have more capabilities than a smaller robot.

The topic ended in agreement that functionality and appearance should be balanced in relation to each other, but also in relation to the context of use. For instance, a robot that has a great height may feel overwhelming to a bedridden person, and therefore it would not be appropriate. One of the participants explained that devices provided by the state through public services often focus only on the device functionality. But focusing solely on functionality may be perceived by users and those around the users as more stigmatizing. If the care receiver as a user of the device wishes to opt for a finer design (more discreet), then the user should take that additional cost as it is a status symbol for the one using it. Similar examples exist for hearing aids and wearable safety alarms in Norway and Sweden. The robot should also provide stimulation to vulnerable users. Users may tire of the robot if it provides too little stimulation (such as robotic pets), especially after the novelty has worn off. In addition, the robot should be user friendly and easily accessible for the users. The participants understood accessibility of robots as the robot's design being accessible, but not stigmatizing. In the participants' view, accessibility means availability for all: especially for children with variability in their abilities, but also others. One of the participants noted that when robot AV1 (Fig. 1) was used with children with disabilities, all the children were interested in the robot, not only those having disabilities. Similarly, it's important that the users get instructed how to use the robots, but also that they make the communication with the vulnerable people easier. The role of social robots in interaction with vulnerable users could be more a coach or helper in the home, which motivates the user and help with practical tasks, rather than a robot that only monitors a user. The robot should help with practical tasks.

VI. Discussion

One of the important aspects was whether the introduction of the robots in one's social life is optional or forced solutions to compensate the needs of the users. Humans should not be replaced by robots, but rather, robots should be a practical complement. To protect user safety and privacy, robots must not pose a threat. In the study, the importance of determining who is responsible for a robot in a care environment, in a care facility or in the care of an individual was highlighted. It is also important to note that legal responsibility differs based on ownership of the robot: whether the healthcare service provider owns a such robot, or if a such robot is owned by the care receiver him- or herself. Unless the robot is owned by a healthcare facility, authorized personnel cannot operate it or assist users. In the event of an accident, responsibility falls on the owner and the user. These legal thresholds can put legitimate staff in an ethical and moral dilemma in healthcare. For robots to respond to the needs of their users, we must consider who the user is. To minimize dissatisfaction with the technology, the vulnerability principle emphasizes the importance of robots being designed and tested by targeted users before reaching users. A robot's functions should also be adapted to the context in which it will be used. The robots are expected to perform complex tasks like humans, including learning, socializing, and performing daily tasks. Robots should be designed with a foundation that can be customized based on individual needs.

A. *Discussion on the method used*

In this study, SDM was used to collect and analyze the data. It is a structured dialogue method that enables five different steps for analyzing and reflecting around selected themes. We used four types of questions that encompassed descriptions, explanations, synthesis, and actions. Participants' perspectives on social robots used with vulnerable users were balanced with open pre-defined questions asked by the main facilitator to ensure the structured dialogue. The dialogue served as a means of moving forward and towards a deeper understanding and action. Every step of the SDM process was time-limited and awarded in advance. Storytelling depended on the participants' motivation, and immediately created a supportive group environment. The entire SDM process was successful thanks to being led by a skilled facilitator. The workshops sought to put on the agenda valuable personal experiences and assumptions and identify important themes and issues that relate to how robots affect the users' perceptions around the use of robots with vulnerable users. One of the strengths of SDM is that it encourages empowerment by focusing on the experiences of individuals, i.e., users. When several participants discuss the same theme and suggest practical actions that might benefit everyone, these are powerful tools. In addition to being flexible, the method can be used for a longer period if necessary. The SDM requires considerable involvement from participants and can generate valuable local knowledge that can be used to address issues that are important to them.

B. *Implications for Universal Design*

If robots are to be used in care situations or with people in vulnerable situations, then they must be universally designed. The participants raised issues with infrastructure in a home and vulnerable people that can benefit from using universal design techniques. In addition, participants' opinions that the robot needed to be universally designed as a baseline echoes themes that we have noticed in other areas such as the internet of things [23]. Like the internet of things, robots may not have screens or traditional ways of interacting with the technology. On the other hand, robots' mobility brings additional aspects of universal design that need to be considered. Using the workshops was a good first step in identifying potential issues that need to be considered when creating a robot that will be used with vulnerable people. These workshops or other methods that allow users to participate and provide their opinions are essential to aid in mapping the different issues that need to be considered. Combining the user methods with other methods and standards for designing accessible technology should help in creating robots that can be used by as many people as possible, including vulnerable users with variation in their abilities.

C. Implications for HRI studies

The issues raised by the participants show that there still is a need for examining aspects of having a robot helping vulnerable people and how to universally design a robot. This includes research in theory, design, and evaluation. Linking back to universal design, one aspect that could be examined is how to accommodate robot customization in the home and healthcare context. Given this need for customization, there are avenues to explore in how to make the robot customizable, how this can be done by people without having extensive knowledge of robots and making choices about what can and cannot be customized. There is also an interesting area to explore in the use of materials and making interaction work with multiple sense. These tasks will be multidisciplinary work between engineers, designers, users, and healthcare providers; something that HRI work is known for.

VII. Conclusion

We gathered viewpoints from health professionals about the use of robots with vulnerable users in the home and healthcare context and possible universal design or accessibility issues around this. The SDM with additional stories gave participants that were not familiar with social robots a solid base to start discussion. Issues were discussed around ethics, responsibility, user concerns, design, and infrastructure. The information was useful as a step for future work in creating universal designed robots, thus more inclusive robots that can be used by a range of different users: care receivers, informal care givers (e.g., family members), and healthcare professionals. The main contribution of the paper is introducing the SDM method to HRI community, as well as findings around universal design and accessibility of robots, to create more inclusive social robots. In the near future, more studies around universal design and accessibility issues are needed, considering that social robots in home and healthcare will be used by many different stakeholders, with- or without robot literacy.

References

[1] C. Breazeal, K. Dautenhahn, and T. Kanda, "Social Robotics," in *Springer Handbook of Robotics*, B. Siciliano and O. Khatib, Eds. Cham: Springer International Publishing, 2016, pp. 1935–1972. doi: 10.1007/978-3-319-32552-1_72.

[2] M. J. Matarić and B. Scassellati, "Socially Assistive Robotics," in *Springer Handbook of Robotics*, B. Siciliano and O. Khatib, Eds. Cham: Springer International Publishing, 2016, pp. 1973–1994. doi: 10.1007/978-3-319-32552-1_73.

[3] S. Elbeleidy, T. Mott, and T. Williams, "Practical, Ethical, and Overlooked: Teleoperated Socially Assistive Robots in the Quest for Autonomy," in *Proceedings of the 2022 ACM/IEEE International Conference on Human-Robot Interaction*, Sapporo, Hokkaido, Japan, Mar. 2022, pp. 577–587.

[4] I. S. Sjetne, C. R. Tvedt, and Å. Ringard, "Norway," in *Strengthening health systems through nursing: Evidence from 14 European countries*, A. M. Rafferty, R. Busse, B. Zander-Jentsch, W. Sermeus, and L. Bruyneel, Eds. Copenhagen (Denmark): European Observatory on Health Systems and Policies, 2019. Accessed: Mar. 07, 2023. [Online]. Available: http://www.ncbi.nlm.nih.gov/books/NBK545732/

[5] G. Hjemås, Z. Jia, T. Kornstad, and N. M. Stølen, *Arbeidsmarkedet for helsepersonell fram mot 2035*. Statistisk sentralbyrå, 2019. Accessed: Feb. 28, 2023. [Online]. Available: https://ssb.brage.unit.no/ssb-xmlui/handle/11250/2627085

[6] B. R. Connell *et al.*, "The Principles of Universal Design, Version 2.0," The Center for Universal Design, North Carolina State University, Raleigh, NC, Jan. 1997. Accessed: Oct. 28, 2022. [Online]. Available: http://www.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm

[7] N. Matsuhira, J. Hirokawa, H. Ogawa, and Tatsuya Wada, "Universal Design with Robots for the wide use of robots - Core concept for interaction design between robots and environment -," in *2009 ICCAS-SICE*, Aug. 2009, pp. 1654–1657.

[8] D. Saplacan, Z. Pajalic, and J. Torresen, "Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed?," in *Cambridge Handbook on Law, Regulation, and Policy for Human-Robot Interaction*, Cambridge University Press, 2023, p. 31.

[9] D. Saplacan, J. Herstad, and T. Schulz, "T-ABLE - The Robotic Wood Table: Exploring situated abilities with familiar things," *International Journal On Advances in Intelligent Systems*, vol. 13, no. 3 & 4, Dec. 2020, [Online]. Available: https://www.iariajournals.org/intelligent_systems/index.html

[10] B. K. Kim *et al.*, "Universal design of robot management system for daily-life-supporting robots," in *2009 ICCAS-SICE*, Aug. 2009, pp. 1662–1665.

[11] N. Tan, R. E. Mohan, and A. Watanabe, "Toward a framework for robot-inclusive environments," *Automation in Construction*, vol. 69, pp. 68–78, Sep. 2016, doi: 10.1016/j.autcon.2016.06.001.

[12] A. Kirkpatrick, J. O Connor, Campell, and M. Cooper, "Web Content Accessibility Guidelines (WCAG) 2.1." https://www.w3.org/TR/WCAG21/ (accessed Aug. 30, 2022).

[13] M. Qbilat and A. Iglesias, "Accessibility Guidelines for Tactile Displays in Human-Robot Interaction. A Comparative Study and Proposal," in *Computers Helping People with Special Needs*, Cham, 2018, pp. 217–220. doi: 10.1007/978-3-319-94274-2_29.

[14] M. Qbilat, A. Iglesias, and T. Belpaeme, "A Proposal of Accessibility Guidelines for Human-Robot Interaction," *Electronics*, vol. 10, no. 5, Art. no. 5, Jan. 2021, doi: 10.3390/electronics10050561.

[15] M. M. I. Al-Qbilat, "Accessibility requirements for human-robot interaction for socially assistive robots," Ph.D., Universidad Carlos III de Madrid. Departamento de Informática, Madrid, Spain, 2022. Accessed: Jul. 20, 2022. [Online]. Available: https://e-archivo.uc3m.es/handle/10016/35142

[16] R. Labonte, J. Feather, and M. Hills, "A story/dialogue method for health promotion knowledge development and evaluation," *Health Educ Res*, vol. 14, no. 1, pp. 39–50, Feb. 1999.

[17] R. Labonte and J. Feather, *Handbook on Using Stories in Health Promotion Practice*. University of Saskatchewan, 1996.

[18] D. Saplacan, Z. Pajalic, and T. Schultz, "Report on user activities in UD-Robots Project: Are social robots universally designed?," Oslo, Norway, DART/23/22 320685, Dec. 2022.

[19] D. Saplacan, J. Herstad, A. Mørch, A. Kluge, and Z. Pajalic, "Inclusion Through Design and Use of Digital Learning Environments: Issues, Methods and Stories," in *Proceedings of the 10th Nordic Conference on Human-Computer Interaction*, New York, NY, USA, 2018, pp. 956–959. doi: 10.1145/3240167.3240264.

[20] D. Saplacan, J. Herstad, N. M. Elsrud, and Z. Pajalic, "Reflections on using Story-Dialogue Method in a workshop with interaction design students," *Proceedings of Fifth International Workshop on Cultures of Participation in the Digital Age - CoPDA 2018, International Conference on Advanced Visual Interfaces (AVI 2018)*, vol. 2101. CEUR Workshop Proceedings, Castiglione della Pescaia, Grosetto, Italy, pp. 33–43, May 29, 2018. Accessed: May 23, 2018. [Online]. Available: http://ceur-ws.org/Vol-2101/paper5.pdf

[21] V. U. Ellefsen, "– Språkrobot «Romibo» er ikke bra nok," *NRK*, Apr. 14, 2018. https://www.nrk.no/vestfoldogtelemark/_-sprakrobot-_romibo_-er-ikke-bra-nok-1.14005371 (accessed Oct. 06, 2022).

[22] E. Antonioni *et al.*, "Nothing about Us without Us: A Participatory Design for an Inclusive Signing Tiago Robot," in *Proceedings of the 31st IEEE International Conference on Robot & Human Interactive Communication*, Italy, Neaple, 2022.

[23] T. Schulz, K. S. Fuglerud, H. Arfwedson, and M. Busch, "A Case Study for Universal Design in the Internet of Things," in *Universal Design 2014: Three Days of Creativity and Diversity*, H. Caltenco, P.-O. Hedvall, A. Larsson, K. Rassmus-Gröhn, and B. Rydeman, Eds. IOS Press, 2014, pp. 45–54. [Online]. Available: http://ebooks.iospress.nl/volume/universal-design-2014-three-days-of-creativity-and-diversity